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THE GENUS HYPNODON AND ITS ALLIES[1]

ZENNOSKE IWATSUKI[2]

H. A. Crum (1956) recently reported on the synonymy and distribution of *Hypnodon perpusillus* (Thwaites & Mitt.) C.M., with its possible phytogeographic history indicated by the curious tricentric pattern in tropical regions of Africa, South America and Asia. This report served as a stimulus toward the study of an unknown specimen collected in southern Japan, together with two species described from the Philippines and Japan as members of the Dicranaceae and the Pottiaceae, respectively. Because the genus *Hypnodon* is extremely rare and little known and has some characters of the Dicranaceae and the Pottiaceae, it has at various times been placed in these families instead of the Orthotrichaceae, to which it belongs (Chen, 1942; Reimers, 1938; Sakurai, 1954; Toyama, 1935; Williams, 1917).

After carefully examining the type specimens of *Kibunemuscus nipponicus* Toyama (Pottiaceae) from Japan and *Rhabdoweisiella papillosa* Williams (Dicranaceae) from the Philippines, I propose to combine these species with *Hypnodon* and include them in the family Orthotrichaceae. I also describe herein a new genus allied to *Hypnodon* in the subfamily Zygodontoideae.

KEY TO HYPNODON AND ALLIED GENERA

1. Calyptra mitrate 2
1. Calyptra cucullate 3

[1] Contribution from the Botanical Laboratory, The University of Tennessee, N. Ser. 182, and from the Biological Station of the University of Michigan.

[2] Hattori Botanical Laboratory, 3888 Obi, Nichinan-shi, Japan.

2. Peristome teeth with palisade-like markings, hyaline, broadly triangular; upper leaf-cells bearing many papillae on both sides, cell walls incrassate, thick-cornered; costa short-excurrent, having 2 layers of stereid cells; perigonial leaves cuspidate, costate ..... *Hypnodontopsis*
2. Peristome teeth not as above, lanceolate, brown, slightly papillose; upper leaf-cells lax, thin-walled, smooth; costa strong, vanishing well below the apex, having 4-5 layers of stereid cells; perigonial leaves truncate, ecostate..... *Rhachitheciopsis*
3. Perichaetial leaves scarcely differentiated; upper leaf cells small, round and incrassate..... *Zygodon*
3. Perichaetial leaves conspicuous, erect and convolute-sheathing; upper leaf cells large, lax and thin-walled..... *Hypnodon*

Hypnodon nipponicus (Toyama) comb. nov. *Kibunemuscus nipponicus* Toyama, Acta Phytotax. et Geobot. 4: 213-214. *Fig.* 1. 1935. This species was described by the late Mr. Reizo Toyama (Kyoto Imperial University) from Kibune, near Kyoto, central Japan. The species is well known to Japanese bryologists because of the difficulty involved in its classification. This small epiphyte, found on an old cherry tree, has cucullate calyptrae, strongly eight-ribbed capsules with an annulus, erect and convolute-sheathing perichaetial leaves and lax, thin-walled and mammillose upper leaf cells. The lack of peristome teeth presented a problem. In the original description, Toyama (1935) said: "Genus novum in foliorum forma et cellulis mammillatis cum *Bryobrittonia* comparandum, sed nervo in sectione fasciculo stereidarum omnino deficiente jam distinguitur." He also said in Japanese: "It is very difficult to determine the exact position of this genus because of the lack of peristome teeth. The shape of the leaves, however, and the structure of the leaf cells suggest some relationship with *Bryobrittonia*. Although some species of Rhabdoweisioideae (Dicranaceae) have ribbed capsules without peristome teeth, the structure of the leaves, the erect perichaetium, and the development of the annulus are quite different from any member of the Dicranaceae." Considering these characters, he placed *Kibunemuscus nipponicus* in the Pottiaceae subfamily Pottioideae with much hesitation.

Reimers, in a review of Toyama's articles (1938), mentioned that *Kibunemuscus* was related to *Weisiopsis* and *Merceyopsis*. Chen (1942) followed Reimers' opinion and suggested that *Kibunemuscus* probably should be combined with *Weisiopsis* in the subfamily Merceyoideae, while *Bryobrittonia*[3] was related to

[3] The genus *Bryobrittonia* was described from sterile plants collected in

Desmatodon of the subfamily Pottioideae. Sakurai (1954) placed *Kibunemuscus* after the genus *Pottia* in his *Muscologia Japonica.*

Referring to Crum's detailed description and figures of *Hypnodon perpusillus,* I compared several specimens of the species with three specimens (including the type) of *Kibunemuscus.* I found that the characters mentioned by Toyama for *Kibunemuscus* and those listed by Crum for *Hypnodon* were practically the same, except for the peristome teeth. I suspect that *Kibunemuscus* originated from *H. perpusillus* by reduction of the peristome teeth. Although Toyama did not find any antheridia in the type specimen of *Kibunemuscus,* I found some in an isotype.

Because the description of *Kibunemuscus nipponicus* is not readily available to American bryologists, I am including it here with some revision:

Plants small, densely matted on bark, green when fresh, yellowish with age. Stems (with leaves) about 3-4 mm. high, sparsely branched, with smooth, brown radicles below, round in cross-section, without central strand, composed of lax, thin-walled cells. Leaves folded lengthwise and slightly crisped when dry, erect-spreading when moist, lower ones small and spatulate, upper ones crowded, obovate-spatulate, broadly acute at tips, about 1.7 mm. long, 0.54 mm. wide, margins subcrenulate toward the apex, occasionally narrowly and shortly involute below; distal cells of leaves roundish-hexagonal, about 18-25 μ in diameter, mammillose, lax and thin-walled, chlorophyllose when fresh; basal cells of leaves rectangular, 50-75 μ long, 20-25 μ wide, hyaline and smooth, thin-walled, marginal cells narrow. Costa slender, vanishing well below the leaf apex, dorsally conspicuous, in cross-section with 2 layers of stereid cells. Gemmae unknown.

Inflorescence autoicous. Perichaetial leaves 3, conspicuous, erect and convolute-sheathing, 1.0-1.1 mm. long, extending to 0.15-0.3 mm. below base of urn, pale yellow, oblong-lanceolate, broadly acute at apex; costa slender, ending well below the apex of the leaf; cells thin-walled and hyaline, those at apex rhombic, 25-35 μ long, others rectangular, about 70 μ long, 15 μ wide. Vaginula about 0.6 mm. high; archegonia few, paraphyses none. Perigonial leaves small, gemmiform, rounded-ovate, excavate, about 0.3 mm. long; costa obscure, ending well below the leaf apex; cells at apex smooth and round, about 20 μ in diameter, others rectangular, about 35-40 μ long. Antheridia few but large; paraphyses none.

the Yukon and assigned to the Pottiaceae. Steere (1953) recently described the sporophytes from Alaskan plants and showed an obvious relationship to the Encalyptaceae.

Seta smooth, pale yellow, erect or nearly so, about 0.9-1.2 mm. long, usually strongly twisted when dry. Capsule straight and symmetric, 0.75-0.85 mm. long, 0.4-0.45 mm. wide, distinctly 8-ribbed and strongly contracted below the mouth when dry, elliptic and scarcely ribbed when moist; annulus persistent, composed of one row of hyaline cells. Operculum broad-conic, short-rostrate. Exothecial cells rectangular, about 45 μ long, 20 μ wide, incrassate on ribs, thin-walled in the interspaces; suboral cells in 1-2 rows, small and tranversely rectangular. Stomata superficial, restricted to neck. Peristome teeth lacking. Calyptra cucullate, about 0.65 mm. long, 0.55 mm. wide, strongly scabrous by projections of upper ends of cells. Spores spherical, almost smooth, 20 × 20-22 μ.

Specimens Examined. On trunk of *Prunus*, Kibune near Kyoto, Kyoto Pref., central Japan, *R. Toyama* 641, Nov. 25, 1934, isotype (Kumamoto Univ.); same tree, *K. Yamamoto* 23744, Jan. 2, 1939 (NICH); bark of *Chamaecyparis pisifera?*, among firewood in the city of Osaka, Japan, *M. Mizutani* 3071, Feb. 26, 1954 (NICH). The Mizutani specimen was found on firewood sold in Osaka, about 30 miles southwest of Kyoto. Supposedly, this wood was cut in the mountains in the vicinity of Kyoto or Osaka. Discovery of the exact locality of the second station is anticipated.

Hypnodon papillosus (Williams) comb. nov. *Rhabdoweisiella papillosa* Williams, Bull. N.Y. Bot. Garden 8: 333-334, *pl.* 171. 1917. In 1917, Williams described a new genus, *Rhabdoweisiella* (Dicranaceae), from the Philippine Islands, stating that it was related to *Rhabdoweisia* and *Oreoweisia* (especially the latter). It was clearly distinguished from *Oreoweisia*, however, by the ribbed, erect capsules, the broad, smooth peristome teeth and the papillose, cucullate calyptrae. According to Williams' description and figures of this species, the main characters (in addition to the above) are as follows: stem with central strand; thin-walled and lax leaf-cells with prominent, solitary, mammillose papillae on both sides in the upper half of the leaf; leaf cells in lower half smooth, thin-walled, rectangular; costa with two layers of stereid cells, vanishing before reaching apex; erect perichaetial leaves clasping seta; erect capsule with a large, simple annulus.

The plant is corticolous and almost the size of *H. perpusillus* and *H. nipponicus*. Almost all of the characters mentioned above, except the central strand, are more characteristic of *Hypnodon* than of any genus of the Dicranaceae. Although the calyptra of *H. papillosus* was originally described as strongly papillose, it is more accurately described as strongly scabrous. For comparison, the

calyptrae or *H. perpusillus* and *H. nipponicus* are moderately to strongly scabrous (owing to projecting upper cell ends). The papillose leaf cells of *H. papillosus* distinguish it from either of the other species of *Hypnodon*.

SPECIMENS EXAMINED. On the bark of a coffee tree, 1570 m. alt., growing among fine tufts of *Bryum argenteum*, Baguio, Philippines, Oct. 10, 1904, *R. S. Williams* 3131, holotype (NY, US).

KEY TO THE SPECIES OF HYPNODON

1. Peristome lacking; upper leaf-cells about 18-25 μ in diameter, mammillose.....*H. nipponicus*
1. Peristome present; upper leaf-cells less than 20 μ in diameter, smooth or papillose..... 2
   2. Upper leaf-cells 16-19 μ in diameter, smooth; leaf margin subcrenulate toward the apex.....*H. perpusillus*
   2. Upper leaf-cells 12-16 μ in diameter, bearing one papilla on each side; leaf margin crenulate toward the apex.....*H. papillosus*

HYPNODONTOPSIS, A NEW GENUS

In January 1956, Mr. Mizutani and I collected a small moss on the bark of a large *Cryptomeria japonica* in the garden of a Shinto shrine near the Hattori Botanical Laboratory in Nichinan, southern Japan. It had strongly curled setae and eight-ribbed capsules, and the peristome teeth were hyaline with palisade-like markings. Although the thick-walled and strongly papillose leaf-cells and the abundance of propagula suggested a relationship to the genus *Zygodon*, the curled setae were very puzzling.

One year later, Dr. Noguchi found a small, mitrate calyptra in a packet collected from the same tree. During this time, I examined many specimens of *Hypnodon* and *Rhachitheciopsis* as well as the Japanese specimen. We reached independent conclusions that this species represents a new genus of the Orthotrichaceae allied to *Hypnodon* and *Rhachitheciopsis*.

Hypnodontopsis Iwatsuki et Noguchi, gen. nov. Caulis erectus, brevis, in sectione transversa irregulariter rotundus, sine centrali fasciculo. Folia oblongo-spathulata vel ligulato-spathulata, apiculata, nervo excurrente et breviter cuspidato, in sectione transversa tribus stratis cellularum composita, duobus parietibus crassis, cellulis ventralibus magnis, parietibus tenuibus. Cellulae foliae rotundato-hexagonales, densissime papillosae, parietibus crassis, basilares laxae, oblongae, magnae, hyalinae. Autoicus. Folia perichaetialia haud differentia. Folia perigonialia parva, breviter cuspidata, costa tenui. Seta madida et sicca tantum sinistrorsa et sursum torta. Capsula sicca subcylindrica valde 8 sulcis ornata.

Peristomium simplex, dentibus late deltoideis, pellucidis, cellulis in duobus stratis, oblongis, in multis seriebus libratis ornatis. Calyptra laevissima, mitriformis, nec plicata, nec pilosa, lutea. Sporae magnae. Annulus simplex, fugax.

Hypnodontopsis apiculatus Iwatsuki et Noguchi, sp. nov. Planta corticola, parva. Caulis circa 2-3 mm. altus. Folia inferior oblongo-spathulata, 0.6-1.1 mm. longa, 0.2-0.35 mm. lata, superior ligulato-spathulata, 1.1-1.3 mm. longa, 0.25-0.33 mm. lata. Cellulae basilares oblongae, lucidae, laeves, 45-80 μ longae, 11-17 μ latae, mediae et superiores rotundato-hexagonae, 7-10 μ longae, 7-11 μ latae, valde papillosae. Propagula 7-11 cellulis composita. Vaginula circa 0.3-0.5 mm. alta. Folia perigonialia circa 0.5 mm. longa. Capsula circa 1 mm. longa, symmetrica, haud immersa. Sporae magnae, 35-40 μ crassitudine.

Plant small, gregarious to loosely matted, soft, dark green. Stems 2-3 mm. high, erect, simple or sparsely branched, with abundant, smooth, hyaline to brownish radicles below; transverse section more or less isodiametric, about 0.1 mm. in diameter, with lax, thin-walled, hexagonal cells about 30 μ in diameter; central strand lacking. Lower leaves small, oblong-spatulate, 0.6-1.1 mm. long, 0.2-0.35 mm. wide; upper leaves larger and crowded, loosely and somewhat spirally appressed when dry, erect-spreading when moist, ligulate-spatulate, 1.1-1.3 mm. long, 0.25-0.35 mm. wide; margin plane, subcrenulate by papillae; costa shortly excurrent, about 25-30 μ wide at midleaf, wider and inconspicuous below. Costa in midleaf with 2 layers of stereid cells and 1 layer of large, thin-walled ventral cells, at the basal portion of the leaf with two layers of thick-walled cells, larger on the ventral side, smaller on dorsal. Cells of upper portion of the leaves small, round to round-hexagonal, chlorophyllose, with thickened corners, bearing 3-5 papillae on the upper and lower surfaces of each cell, 7-10 μ long, 7-11 μ wide at midleaf, slightly smaller at margin. Cells of lower portion of leaves large, hyaline, rectangular, smooth (28)45-50(80) μ long, 11-17 μ wide, shorter toward the base, about 15-25 μ long. These large cells usually extend to the lower ⅓-⅔ of the leaves. Propagula abundant on the upper surface of leaves, dark brown, 120-240 μ long, 40-50 μ wide, composed of 7-11 cells.

Inflorescence autoicous. Perichaetia terminal; perichaetial leaves almost the same size as the other leaves, the 2-3 innermost perichaetial leaves slightly broader and more slenderly acuminate; costa narrow and ending a little below the apex; cells of upper part rhombic, thick-walled, less chlorophyllose (11) 17-28 μ long, 7-10 μ wide, 2-4 papillose, toward the base long and rectangular, hyaline.

Vaginula about 0.3-0.5 mm. high; archegonia few with few paraphyses. Perigonia bud-shaped; inner leaves small, rounded-ovate, excavate, abruptly short cuspidate, about 0.5 mm. long, plane and entire at margin; costa slender, percurrent, only cells of the apical part papillose; most leaf cells smooth and pellucid; antheridia few, large, subcylindric; paraphyses none.

Setae strongly spiraling to the left both wet and dry; cross-section long-elliptic, two rows of outer cells strongly incrassate at one side, though cells of other side slightly thick-walled. Capsule barely exserted above the leaves, straight and symmetric, about 1 mm. long, narrowly subcylindric, strongly 8-ribbed and contracted below the mouth when dry, elliptic to subglobose when moist. Operculum small, almost flat, about 0.25 mm. in diameter; annulus pale, of one row of cells; exothecial cells thick, darker-walled on ribs, thin-walled between the ribs, rectangular, 35-60 μ long, 10-15 μ wide in middle part; stomata obscure. Peristome teeth 8, incurved when moist, reflexed when dry and old, hyaline, broadly triangular, with palisade-like markings, having many longitudinal and transverse bars, about 60 μ high, 70 μ wide at base. Spores 35-40 μ in diameter, faintly and minutely punctate in surface view. Calyptra mitrate, yellow, shortly rostrate, tip brown and slightly mammillose to scabrous, about 0.3 mm. long, not plicate or pilose. (Fig. 7-29.)

Specimens Examined. On bark of *Cryptomeria japonica* in a garden of a Shinto shrine, ca. 10 m. alt., Nichinan-shi, Hiyazaki, Japan, *M. Mizutani*, 35567, Jan. 23, 1957, holotype (NICH, TENN); same locality, *Z. Iwatsuki & M. Mizutani* 29432, 29433, Jan. 22, 1956, isotype (NICH). An isotype specimen is also located in the Herbarium of Kumamoto University. This species is known only from the type locality. However, I collected a sterile moss on the bark of a *Cryptomeria japonica* in the garden of Inuyama Castle, in central Japan, in August 1956; it may prove to be the same species.

The genus most closely related to *Hypnodontopsis* is *Rhachitheciopsis* (fig. 1-6), described from tropical Africa by Potier de la Varde in 1926. Both genera have strongly curled setae. Cross-sections of setae of the two show very thick-walled cells in the outer layer on one side. The seta of *Hypnodontopsis* is elliptic in cross-section with the thick-walled cells in two rows on one side, while that of *Rhachitheciopsis* is almost round with three rows of thick-walled cells on one side and one row on the other side. In cross-section the seta of *Hypnodon perpusillus* is slightly anisodiametric (3: 2) while that of *H. nipponicus* is isodiametric. The difference in thickness of cells in the outer layer results in a curled

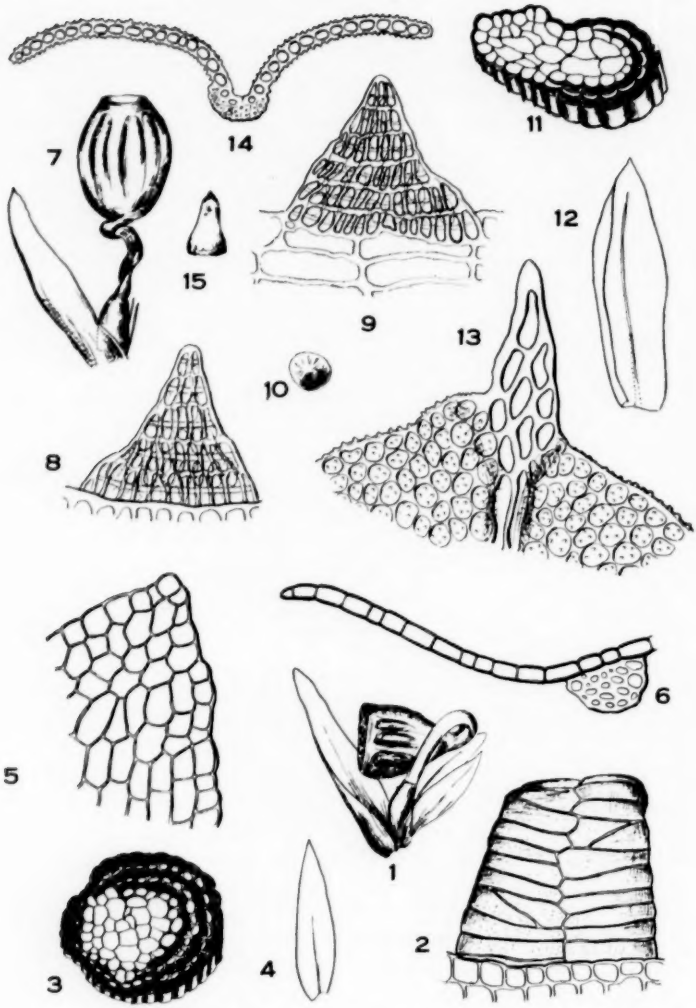

FIG. 1-6. *Rhachitheciopsis tisserantii.* 1. Sporophyte with perichaetial leaves, moist, × 20. 2. Peristome tooth, × 308. 3. Cross-section of seta, × 190. 4. Perichaetial leaves, × 26.6. 5. Areolation at leaf apex, × 308. 6. Cross-section of leaf, × 190.

FIG. 7-15. *Hypnodontopsis apiculatus.* 7. Sporophyte with perichaetial leaves, moist, × 20. 8. Outer view of peristome tooth, × 308. 9. Inner view of peristome tooth, × 308. 10. Operculum, × 20. 11. Cross-section of seta, × 190. 12. Perichaetial leaf, × 26.6. 13. Areolation of leaf apex, × 308. 14 Cross-section of leaf, × 190. 15. Calyptra, × 28.

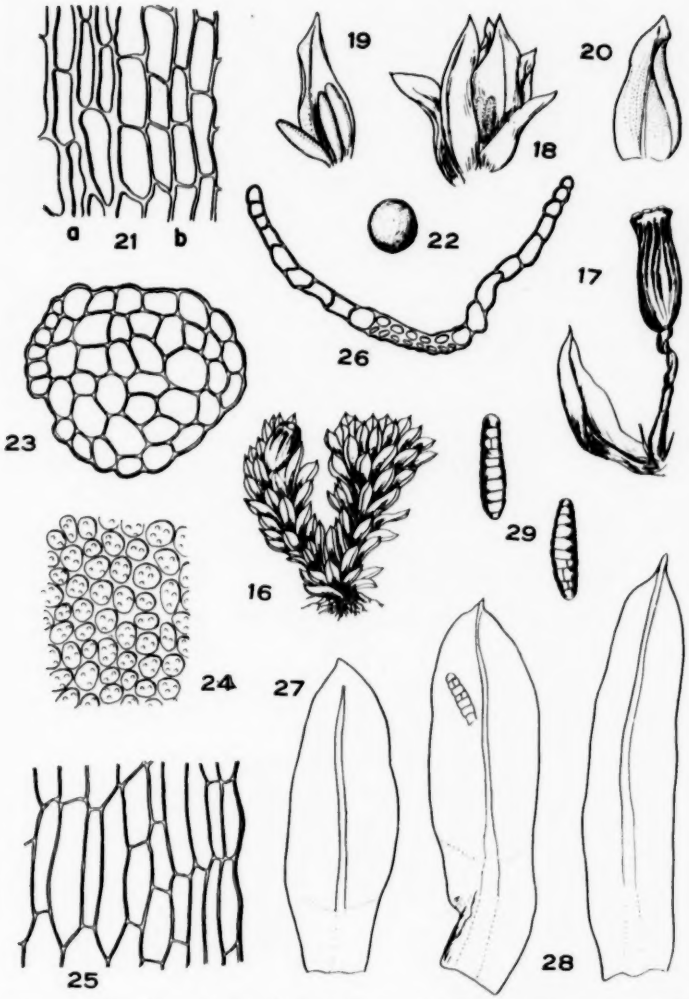

FIG. 16-29. *Hypnodontopsis apiculatus*. 16. Plant, moist, × 10. 17. Sporophyte with a perichaetial leaf, dry, × 20. 18. Perigonium, × 43. 19. Perigonial leaf with three antheridia, × 43. 20. Perigonial leaf, × 43. 21. Exothecial cells, (*a*) on rib, (*b*) between ribs, × 190. 22. Spore, × 190. 23. Cross-section of stem, × 190. 24. Areolation of middle part of stem leaf, × 308. 25. Areolation of basal part of stem leaf, × 308. 26. Cross-section of basal part of stem leaf, × 190. 27. Lower stem leaf, × 43. 28. Upper stem leaves, × 43. 29. Propagula, × 71.

seta. The peristome teeth of *Hypnodontopsis* seem to consist of two layers of hyaline cell-walls which cross each other, making multiple palisade-like markings (*fig.* 8, 9). The peristome teeth of *Hypnodontopsis* are similar only to those found in the genus *Palisadula* of the Sematophyllaceae, described from southern Japan by Toyama.

Another difference between *Hypnodontopsis* and *Rhachitheciopsis* is the structure of the upper leaf cells. Those of *Hypnodontopsis* are smaller, thick-walled and chlorophyllose and bear three to five papillae on each side, while those of *Rhachitheciopsis* are larger, thin-walled, lax and smooth. In other words, the upper leaf cells of *Rhachitheciopsis* are much like *Hypnodon*, while those of *Hypnodontopsis* are similar to *Zygodon* and other members of the Orthotrichaceae. The costa of *Rhachitheciopsis* is stronger than that of *Hypnodontopsis* and more conspicuous dorsally, having four to five layers of stereid cells. The perigonial leaves of *Rhachitheciopsis* are ecostate and have obtuse and truncate apices with incurved margins. In contrast, those of *Hypnodontopsis* are costate and abruptly cuspidate. The spores of *Hypnodontopsis* are the largest (35-40 μ) among the three genera and about twice the size of *Rhachitheciopsis* (18-21 μ). Very few propagula are found on the leaves of *Rhachitheciopsis*, but they are similar to those of *Hypnodontopsis*.

Bryogeographical Considerations

The first part of this paper indicates that the known range of *Hypnodon* in Asia has been expanded to include Japan and the Philippine Islands in addition to Ceylon, India and China (Yunnan). It also occurs in Africa, Madagascar, South America, and Mexico (Crum 1956a, b). This disjunct type of distribution would be surprising were it not already known for other bryophytes. Hattori (1951) in his study of the hepatics of Kiushiu and Shikoku of southern Japan found that 18% of the total species known belong to the Indomalayan and Oceanic elements (sometimes called the Tropical element). He thought that this element which is most widely distributed in the tropics and southern hemisphere represents the oldest segment of the flora.

Such a tropical element is also recognized in the moss flora of Japan. Noguchi (1951) pointed out that the Leucodontineae and Neckerineae in Japan and adjacent regions are chiefly repre-

sented by temperate and Indomalayan elements. Some members of the latter element grow luxuriantly in southern Japan where their ranges are contiguous to or overlap those of closely related Japanese endemic species which were perhaps derived from them.

Neckeropsis lepineana is found in tropical Asia, eastern Africa and the islands of the South Pacific. It had been reported from Japan, but the Japanese material has subsequently been shown by Noguchi (1956) to be a closely-related species, *N. calcicola*, which he described. The known range of *Haplohymenium pseudotriste* includes Japan, tropical Asia, South Africa, Australia and New Zealand (Noguchi, 1957). *Hyophila involuta* is almost worldwide in distribution: Japan, China, Himalayas, tropical Asia, New Guinea, Central Europe, West Indies, Mexico to South America, and in eastern North America (Sharp, 1955) under the synonym, *H. tortula*. Ochi (1957) reported *Bryum ramosum* from Pan-Pacific and Indomalayan areas (including the western coasts of North and South America) and suggested that its range was perhaps tricentric.

The number of such examples can be increased by further study of tropical bryophytes and their ranges in comparison with those of related Japanese species. It is predicted that others of the Indomalayan element will be found in the Philippines, the Himalayas and adjacent regions and Japan.

Specimens examined for this report were made available through the kindness of Dr. H. A. Crum of National Museum of Canada, Dr. D. D. Keck of New York Botanical Garden, Dr. M. E. Hale of U. S. National Herbarium, Dr. A. Noguchi of Kumamoto University, and Dr. S. Hattori and Mr. M. Mizutani of Hattori Botanical Laboratory. Thanks are due these curators for their many suggestions and aid. I am also indebted to Dr. A. J. Sharp and Mr. H. Sherman of the University of Tennessee for their suggestions and editing of the manuscript; also to Dr. A. H. Moser for his aid with the Latin descriptions.

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BRYOPHYTES OF ALASKA. II. ADDITIONS TO THE MOSSES AND HEPATICS OF THE MT. McKINLEY REGION

ELIZABETH M. SHERRARD[1]

The Mount McKinley region lies within the floristic division which Hultén (1941) has called the Alaska Range district. To this division belongs the Alaska Range which extends from the Yukon Territory through central Alaska and sweeps southwest in a crescent to the Alaskan Peninsula. It is one of the major ranges in North America and forms, for the most part, the divide between the Pacific Ocean and the Bering Sea. Northward the mountains become more rugged culminating, at the northwestern corner, in the towering mass of Mt. McKinley, North America's highest peak. To the north of the Alaska Range is Mount McKinley National Park, a wilderness area of approximately two million acres (148° 49′ to 152° 13′ W. Long., 62° 49′ to 63° 48′ N. Lat.). It is mostly an alpine region, but some stands of *Picea glauca* are found along the rivers, and alder and willow thickets skirt the creeks and

[1] 27 E. Wheelock St., Hanover, N. H.

draws. Much of the area is under shrub cover of *Betula glandulosa* or *Salix* spp. with a ground cover of *Ledum, Empetrum, Vaccinium,* some sedges and lichens. *Dryas,* a favorite food of the Alaska mountain (Dall) sheep, is the dominant plant of the higher slopes where alpine meadow soils are widespread. The region is subject to great extremes in temperature (89°F. and −51°F.) and the total annual precipitation is scant (8.45 to 22.66 in.).

The specimens on which this report is based were all taken within Park boundaries except for collections made at Kantishna (63° 31′ N. Lat., 150° 58′ W. Long.), situated about three miles northwest of the Park, and at Garner (63° 50′ N. Lat., 148° 51′ W. Long.), a station on the Alaska Railroad a few miles north of the northeastern Park limit. The collecting sites within the Park are CATHEDRAL MOUNTAIN (approximately 63° 33′ N., 149° 30′ W.); CARLO (63° 34′ N., 148° 50′ W.); CAMP EILSON (63° 25′ N., 150° 15′ W.); HORSESHOE LAKE (63° 44′ N., 148° 55′ W.); LAGOON (63° 41′ N., 148° 51′ W.); POLYCHROME PASS (63° 33′ N., 149° 50′ W.); TRIPLE LAKES AND RILEY CREEK (63° 42′ N., 148° 56′ W.); WONDER LAKE (63° 29′ N., 150° 51′ W.). Most of the collecting was done on (1) the Birch Creek Schist believed to be early pre-Cambrian and the oldest group of rocks in this region, (2) the Cantwell formation assigned to the Upper Cretaceous and on (3) glacial moraines and washout gravels belonging to the Quaternary.

In July, 1951, Dr. Hannah Croasdale of Hanover, N. H., and the author spent 18 days collecting freshwater algae, mosses and lichens in the McKinley region.[2] Prior to 1951, no collections of algae were known from this area, and no bryologists had worked there. Previous moss collections, however, had been made by several botanists whose primary interest was in vascular plants, and in 1946 Mr. Clyde Wahrhaftig, a geologist, also collected mosses in the district (Harvill, 1947a). The recently completed highway to Mt. McKinley Park has now made this whole area accessible, and because of the extremely rich moss flora of

[2] Field work done under the auspices of the Arctic Institute of North America, with funds provided by the Office of Naval Research. Thanks are due to Mrs. Ethel P. Hutchinson who, with the author, has determined all specimens (except where otherwise indicated) and without whose help this report would not have been accomplished; Dr. A. LeRoy Andrews for his unfailing help and advice, for identifications of critical species and for determining the *Sphagna* in the collection; Dr. H. Persson for many identifications, for assistance in taxonomy and distribution and for his interest and encouragement; and also Dr. H. Crum and Dr. Hannah Croasdale for their valuable help at all times.

the district, Mt. McKinley Park will no doubt become a center for intensive bryological study and research.

MUSCI

Aloina brevirostris (Hook & Grev.) Kindb. Carlo, on clay of dried section of Lagoon, C47.

**Amblystegiella sprucei* (Bruch) Loeske. Horseshoe L., on spruce and alder stumps, C37, C40. Previous records are Eastern and Central Pacific Coasts, Aleutian Islands (Harvill, 1947); Central Yukon River (Persson, 1952; Sherrard, 1955); Yukon Territory (Williams, 1901).

**Amblystegium juratzkanum* Schimp. (*det.* Crum). Horseshoe L., on white spruce log, C46. One earlier Alaskan record: Central Yukon River (Sherrard, 1955).

**A. serpens* (Hedw.) BSG. Horseshoe L., on alder log, C40, Kantishna, on schist boulder, B69. Known from Eastern Pacific Coast and Bering Sea (Cardot & Thériot, 1902); Aleutian Islands (Harvill, 1947); Central Yukon River (Williams, 1903).

**Aongstroemia longipes* (Sommerf.) BSG. (*det.* Andrews). Kantishna, silt of creek bed, A23. Reported from Eastern Pacific Coast (Cardot & Thériot, 1902); Arctic Alaska (Steere, 1954); Central Yukon River (Persson, 1946; Sherrard, 1955).

Aulacomnium acuminatum (Lindb. & Arn.) Par. (*det.* Andrews). Triple L., (immature plants) on soil with *Leptobryum pyriforme* and other mosses, C7.

A. palustre (Web. & Mohr) Schw. Wonder L., on wet mud of pot-hole, A16, A49, B57. Triple L., on mud in stagnant pool, C20, A31.

A. turgidum (Wahl.) Schw. Wonder L., soil and gravel, broken ground, C3; mud of pot-hole, B55, B57; peaty, moist soil, C21.

**Barbula convoluta* Hedw. (*leg. et det.* W. C. Steere). McKinley Park Station, on fine soil, E11. The two earlier Alaskan records for this species are both from Central Yukon River (Sherrard, 1955).

Bartramia ithyphylla Brid. Triple L., on shaded bank, C26.

***Blindia polaris* (Berggr.) Hag (*det.* Persson). Kantishna, on dry, disintegrating schist, no soil, in shade of overhanging rocks, outcrops on upland tundra, C2. An arctic species known only from northern Scandinavia, Spitzbergen (type locality, Berggren, 1875), Ellesmere (Bryhn, 1906), Cornwallis Island (Steere, 1951) and from several arctic Alaskan locations which have not yet been published (Steere *in lit.*). Kantishna is a considerable extension southward for this species.

Brachythecium albicans (Hedw.) BSG. Kantishna, on sandy soil of bank formed by flood waters, A45, C11; Riley Creek, moist leaf mold of forest floor, C49.

B. glareosum (Bruch) BSG (*det.* Andrews). Wonder L., on stones in pot-hole, A11.

**B. salebrosum* (Web. & Mohr) BSG. Horseshoe L., on thin soil of

*Two asterisks mark species new to Alaska, one those new to the Alaska Range.

rocky slope, A36 (*det.* Persson). Kantishna, on rotting wood in alder thicket, A37. Previously reported from Eastern Pacific Coast and Aleutian Islands (Cardot & Thériot, 1902); Bering Strait (Macoun, J., 1892); Central Yukon River (Holzinger & Frye, 1921; Sherrard, 1955); Yukon Territory (Williams, 1901).

**Bryobrittonia pellucida* Williams. Carlo, on silt, bank of Nenana River, C34. Carlo marks the southern limit for the known distribution for this Alaska-Yukon endemic. Originally found at Dawson, Yukon Territory (Williams, 1901), it has since been reported from Bering Strait (Persson, 1946) and from several locations in arctic Alaska and Central Yukon River (Steere, 1953).

**Bryum archangelicum* BSG (*det.* Andrews). Kantishna, on soil and gravel, exposed, C25. Triple L., on moist, shaded bank, B38. This species has been previously reported from Bering Sea (Cardot & Thériot, 1906; Arnell, 1917); Arctic Alaska (Steere, 1954). Dr. Persson, who saw duplicate material, thought these probably *B. pallescens*, with poor fruits.

**B. arcticum* (R. Br.) BSG. Kantishna, on earth floor of deserted mining shack, B5, *c. fr.* Previous records for this circumpolar, arctic-alpine species on Eastern Pacific Coast and Bering Strait (Persson, 1952); Aleutian Islands (Persson, 1947); Arctic Alaska (Steere, 1954); Yukon Territory (Williams, 1901).

B. argenteum Hedw. Carlo, newly broken ground, B33, B20; Kantishna, on schist with *Grimmia tenuicaulis*, B62.

B. caespiticium Hedw. Horseshoe L., on alder, C40. Kantishna, on fine soil, A45. Wonder L., newly broken ground, A73; on gravel by pool, B47.

B. cuspidatum (BSG) Schimp. Kantishna, on fine sandy soil, C24. Riley Creek, on rotting wood, B25.

**B. inclinatum* (Web. & Mohr) Sturm (*det.* Persson). Polychrome Pass, on alpine slope, M10. Widespread in Oceanic Alaska and Aleutian Islands, and known from several locations in Bering Sea (Cardot & Thériot, 1902 and 1906; Bartram, 1938; Holzinger & Frye, 1921; Merriam, 1892); Bering Strait (Arnell, 1917; Rothrock, 1867); Central Yukon River (Sherrard, 1955).

**B. pallens* (Web. & Mohr) Brid. Kantishna, on silt of creek bed with *Aongstromia longipes*, A24 (*det.* Andrews). Wonder L., wet soil in pothole with *Dicranella crispa*, B49, *c. fr.*; on hummock of gravelly beach, B56. Listed by Persson (1952) from Eastern, Central and Western Pacific Coasts, Aleutian Islands, Arctic Coast and Yukon Territory.

**B. pallescens* Schleich. Kantishna, moist soil of shaley bank with *Oligotrichum laevigatum* v. *cavifolium*, B51. Wonder L., on moist bank of ditch, B59. Widespread in Oceanic Alaska and recorded from Bering Sea (Cardot & Thériot, 1902) and two locations in Arctic Coast (Williams, 1921).

B. pseudotriquetrum (Hedw.) Schw. Wonder L., on wet, loamy soil, A27; on saturated soil in depression, A66 (*det.* Persson).

**B. turbinatum* (Hedw.) Schw. Carlo, on bank of mountain stream,

A62. There are several records for Oceanic Alaska (Harvill, 1948) and one for Yukon Territory (Williams, 1901).

Calliergon giganteum (Schimp.) Kindb. Garner, on decaying grass at edge of pond with *Campylium polygamum*, C45, A41. Lagoon, submerged in deep pool, B11.

C. sarmentosum (Wahl.) Kindb. Carlo, clinging to rocks in swift-flowing mountain stream, B29 (*det.* Persson). Wonder L., submerged A55 (*det.* Andrews); on stones in pot-hole, A77.

C. stramineum (Brid.) Kindb. Wonder L., on wet, peaty soil, A35, *c. fr.* (*det.* Conard); under grass at edge of pool, B42 (*det.* Persson).

Calliergonella schreberi (BSG) Grout. Carlo, Kantishna, Triple L., Wonder L. One of the most common mosses of the region, especially in the Wonder Lake district where it was collected 11 times usually in small amounts growing through other mosses.

**Camptothecium nitens* (Hedw.) Schimp. Triple L., on rotten wood, A29. Wonder L., submerged, C53. Listed by Harvill (1948) from Eastern Pacific and Central Pacific Coasts, Bering Sea, Bering Strait and reported also from several localities in Central Yukon River (Harvill, 1948; Sherrard, 1955).

**Campylium polygamum* (BSG) Bryhn. Garner, on decaying grass blades, C45, C28. Earlier records are Eastern Pacific Coast (Cardot & Thériot, 1902); Central Pacific Coast and Aleutian Islands (Persson, 1952a); Central Yukon River (Persson, 1952a; Williams, 1901).

**C. stellatum* (Hedw.) Lange & Jens. Wonder L., on rock at edge of pool, B26; on clay bank, B65; on decaying *Vaccinium* leaf mold and wet soil, A66, A67, A68. **C. stellatum* ad var. *subfalcatum* Geheeb. Kantishna, on moist gravel in creek bed, B15. For discussion of this variety see Persson (1952).

Catoscopium nigritum Brid. Polychrome Pass, on *Dryas* sod and in willow growth, S5.

Ceratodon purpureus (Hedw.) Brid. Kantishna, Polychrome Pass, Triple L., Wonder L. Collected 11 times.

Cinclidium stygium Sw. (*det.* Andrews) Cathedral Mt., on bank of highland tundra stream, altitude 4000′, B37 (*leg.* G. Murie).

Climacium dendroides (Hedw.) Web. & Mohr (*det.* Andrews). Kantishna, on rotting wood in alder thicket with *Brachythecium salebrosum*, A37.

Cirriphyllum cirrosum (Schw.) Grout. Kantishna, on moist soil in partial shade, A3, A2. Garner, on soil of dried pot-hole with willow and *Vaccinium*, B18.

Conostomum boreale Sw. Polychrome Pass, rock outcrops, on alpine slope above tree line, B24. (*leg.* G. Murie.)

Cratoneuron falcatum (Brid.) Roth. Polychrome Pass, in water trickle, S2, *c. fr.*

**C. filicinum* (Hedw.) Roth. Horseshoe L., thin soil of rocky slope, A36 (*det.* Persson). Wonder L., at base of willow, B2 (*det.* Crum); on gravelly soil at edge of stream, C35, A34. Recorded from several localities in Eastern Pacific Coast (Harvill, 1948); Arctic Coast (Williams, 1921); Central Yukon River (Sherrard, 1955); Yukon Territory (Stair, 1947).

Cynodontium strumiferum (Hedw.) DeNot. (*det.* Persson). Carlo, on rock at edge of stream, B30. Wonder L., on schist in open tundra, B63.

C. tenellum (BSG) Limpr. (*det.* Persson). Wonder L., exposed on schist, B13.

**Dicranella cerviculata* (Hedw.) Schimp. [*D. polaris* Kindb.]. Kantishna, newly broken soil, A12. Previous records are from Central and Western Pacific Coasts (Harvill, 1948); Bering Sea (Persson, 1952; Cardot & Thériot, 1906; Macoun, J., 1902); Bering Strait (Cardot & Thériot, 1906); Yukon Territory (Williams, 1903).

D. crispa (Hedw.) Schimp. Kantishna, on stones and mud in creek bed, B44. Wonder L., on wet soil, B49.

D. heteromalla (Hedw.) Schimp. Wonder L., on newly broken ground, a few plants only, with *Polytrichum juniperinum* and seven other mosses and hepatics, C3.

**D. subulata* (Hedw.) Schimp. [*D. secunda* (Sw.) Lindb.] (*det.* Crum). Wonder L., on newly broken ground, C3, B39, B28. Recorded from two locations in Bering Sea (Macoun, J., 1892) and reported from Yukon-British Columbia boundary (Williams, 1901).

**D. varia* (Hedw.) Schimp. [*D. rubra* (Huds.) Kindb.]. Carlo, moist soil and gravel, A32. Wonder L., mud in pot-hole, B27, B45. The two previous Alaskan records are Bering Strait (Arnell, 1917); Central Yukon River (Sherrard, 1955). Reported also for Yukon Territory (Williams, 1901).

**Dicranoweisia crispula* (Hedw.) Lindb. (*det.* Persson). Kantishna, on schist, dry, exposed, C4. A widespread species in Oceanic Alaska. Other records are from Bering Sea (Cardot & Thériot, 1902); Macoun, J. M., 1899); Bering Strait (Cardot & Thériot, 1902); Central Yukon River (Sherrard, 1955); British Columbia (Williams, 1901).

**Dicranum acutifolium* (Lindb. & Arn.) Jens. [*D. rupincola* (Kindb.) Perss.] (*det.* Persson). Garner, thin soil on rock outcrops on wind-swept tundra with *D. bergeri* and *D. elongatum*, C30. Earlier records are Central Yukon River and Yukon Territory (Persson, 1954).

**D. arcticum* Schimp. [*D. glaciale* Berggr.; *D. molle* Wils.] Kantishna, on moist gravel of creek bed, B15. Wonder L., grass hummock on gravel beach, B70. This species is recorded from all divisions of Oceanic Alaska including the Aleutian Islands and also Bering Sea and Lower Yukon River (Persson, 1949). Other records are Bering Sea (Macoun, J. M., 1899; Arnell, 1917) and Upper Yukon River (Williams, 1901).

D. bergeri Bland. Horseshoe L., on leaf mold and lichens, E10 (*leg. et det.* W. C. Steere). Garner, thin soil on rock outcrop on wind-swept tundra, C30 (*det.* Persson).

D. elongatum Schleich. Garner, thin soil on rock outcrops on wind-swept tundra, with *D. acutifolium* and *D. bergeri*, C30 (*det.* Persson). Sable Mountain, exposed on wet earth of stream bed, M10.

D. fuscescens Turn. Carlo, on leaf mold in white spruce and willow grove, C23. Kantishna, schist, exposed, A9. Wonder L., on soil with grass, A8.

**D. groenlandicum* Brid. Kantishna, on dry soil, exposed, A53 (*det.* Crum). Wonder L., bank of pot-hole, B66, *c. fr.* (*det.* Andrews). Listed by Persson (1952a) for Central and Western Pacific Coasts and Bering Strait. Other records are Western Pacific Coast (Holzinger & Frye, 1921); Bering Sea, Bering Strait, Yukon River (Cardot & Thériot, 1902 and 1906) and Bering Sea (Holzinger, 1902).

D. muehlenbeckii BSG. Kantishna, on schist, exposed, A4. Wonder L., on dry soil, A36; on moist soil of tundra, A78, C21.

D. scoparium Hedw. Carlo, on wet soil of birch muskeg with *Ptilidium ciliare*, C44.

**Didymodon recurvirostris* (Hedw.) Jenn. Horseshoe L., on soil of rocky slope, shade, A26; trunk of white spruce, moist, C37. Listed from many localities in Oceanic Alaska (Harvill, 1948) and recorded also from Bering Sea (Merriam, 1892; Cardot & Thériot, 1902; Arnell, 1917); Bering Strait (Arnell, 1917); Central Yukon River (Harvill, 1948; Sherrard, 1955); Yukon Territory (Williams, 1901).

Distichium capillaceum (Hedw.) BSG. Horseshoe L., on trunk of white spruce, C37; alder stump, C40. Kantishna, on schist, C17; thin soil over schist, B32.

**D. inclinatum* (Hedw.) BSG. Kantishna, on creek bank, C27. Known previously from Central Pacific Coast, Bering Strait, Yukon Territory (Persson, 1952a); Arctic Alaska (Steere, 1954); Central Yukon River (Sherrard, 1955). Williams (1901) also recorded it for both Upper and Central Yukon River.

**Ditrichum flexicaule* (Schw.) Hampe. Kantishna, on moist soil of upland tundra, with *Blepharostoma trichophyllum* and four mosses, A3 (*det.* Crum); on schist, dry, exposed with *Rhytidium rugosum* and other mosses, A2 (*det.* Andrews). Circumboreal and one of the most common alpine, arctic and subarctic bryophytes. Known in Alaska from Aleutian Islands (Harvill, 1947); Arctic Coast (Steere, 1954; Harvill, 1948); Central Yukon River (Sherrard, 1955); Yukon Territory (Williams, 1901).

Drepanocladus aduncus (Hedw.) Warnst. (*det.* Andrews). Wonder L., in pool, partially submerged, A18; large mats floating on surface of pool, A69.

D. badius (Hartm.) Roth. (*leg. et det.* W. C. Steere). Horseshoe L., E12.

D. capillifolius (Warnst.) Warnst. (*det.* Persson). Garner, on decaying grass blades, C28, C45. This calciphilous species is little known in North America. Persson (1946) stated that Tuomikoski (1940) has shown it to be a species of high value. It has previously been reported from Bering Sea (Cardot & Thériot, 1906); Eastern Pacific Coast, Alaska Range and Central Yukon River (Persson, 1946); Yukon Territory (Stair, 1947).

D. exannulatus (Gümb.) Warnst. Wonder L., submerged except for tips of plants and fruits, A15; on saturated soil, A35 (*det.* Conard).

D. fluitans (Hedw.) Warnst. Lagoon, submerged, B36, C8.

D. revolvens (C.M.) Warnst. Carlo, thin soil over schist, B32. Wonder L., saturated mud in depressions, All, A17, A55, A66, A67, C9, C15, C52; at base of willow, B2 (*det.* Crum); in rock fissure, B53.

D. tundrae (Arn.) Loeske (*det.* Persson). Lagoon, submerged in deep pool, B11. Wonder L., on wet soil at edge of tarn where caribou were feeding, B52. A pronounced calciphilous species recorded previously from Central Pacific Coast, Alaska Range, Bering Strait (Persson, 1952a); Yukon Territory (Williams, 1901, as *Hypnum amblyphyllum*).

D. uncinatus (Hedw.) Warnst. Carlo, Garner, Horseshoe L., Kantishna, Riley Creek, Wonder L., collected 19 times, often in small quantities in mixture with other mosses.

D. vernicosus (Lindb.) Warnst. (*det.* Crum). Garner, under grass at edge of pond, C39.

Eurhynchium pulchellum (Hedw.) Jenn. Horseshoe L., on alder stump, C40; thin soil on rocky slope, A36 (*det.* Persson).

**Fissidens adiantoides* Hedw. (*det.* Crum). Wonder L., clay bank in alder and willow thicket, B65. Recorded from Eastern and Central Pacific Coasts (Persson, 1954); Aleutian Islands (Persson, 1954; Harvill, 1947); Central Yukon River (Sherrard, 1955); British Columbia (Williams, 1901).

F. osmundioides Hedw. Garner, on peaty soil, under *Betula glandulosa*, C32.

***F. viridulus* (Web. & Mohr) Wahl. (*det.* Persson). Wonder L., on clay bank in willow and alder grove with *F. adiantoides* and other mosses and hepatics, B65, *c. fr.* A widespread circumboreal species: Europe, Asia, Greenland and northern North America extending southward into the United States, especially in the East. Grout (1928) states that this species is "rare west of the Rockies." In the Canadian Eastern Arctic it is known only from the material collected by the Second *Fram* expedition (Bryhn, 1906). "It seems to be rather common in Alaska (records unpublished) and is a more northerly species than *F. bryoides*" (Persson *in lit.*).

**Funaria hygrometrica* Hedw. Carlo, on newly broken ground, B33; on clay in dried section of lagoon with *Aloina brevirostris*, C47. Previous records are Eastern Pacific Coast (Cardot & Thériot, 1902; Stair, 1947a); Central Pacific Coast and Aleutian Islands (Harvill, 1948; Hornschuch, 1820); Bering Sea (Rothrock, 1867); Central Yukon River (Harvill, 1948; Sherrard, 1955) and from several localities in Yukon Territory and British Columbia (Williams, 1901; Cardot & Thériot, 1902).

***Gollania densepinnata* Dixon. A genus and species new to America recorded elsewhere in this issue. Known previously only from two localities in Shensi, China.

**Grimmia apocarpa* var. *gracilis* (Schleich.) Web. & Mohr. Kantishna, on schist, dry, exposed B69. Previously recorded from Eastern & Western Pacific Coasts and Bering Sea (Cardot & Thériot, 1902) and Eastern Pacific Coast (Stair, 1947a).

G. ovalis (Hedw.) Lindb. Kantishna, on rock schist, B3 (*det.* Andrews). Wonder L., on boulders, B34, B54; on disintegrating schist, B63 (*det.* Crum).

**G. tenuicaulis* Williams (*det.* Persson). Kantishna, on schist, exposed, with *Bryum argenteum*, B62. The only Alaskan record for this western North American endemic is from Central Yukon River (Persson & Gjaerevoll,

in press). It has been recorded from Yukon: Marsh Lake and Dawson (Williams, 1901).

**Hygrohypnum luridum* (Hedw.) Dixon. [*H. palustre* (Hedw.) Loeske.] Garner, on rocks in clay-laden stream, C18, *c. fr.* Lagoon, submerged, B36. Wonder L., on rock at water's edge, B26, *c. fr.* (*det.* Persson) Listed from Eastern, Central, and Western Pacific Coasts (Persson, 1952a). Williams (1901) adds records from Eastern Pacific Coast and from two localities in Yukon Territory.

H. ochraceum (Turn.) Loeske. Camp Eilson, on rocks and gravel at edge of stream, A22; submerged under swift-flowing water, C48. Kantishna, on schist, submerged, A13. Lagoon, almost submerged on grass at edge of pond, C8.

***H. norvegicum* (BSG) Grout. [*Hypnum viridulum* Hartm.] (*det.* Persson). Riley Creek, on rock edge of pool, B23 (*leg.* H. Croasdale). The only North American record is from West Greenland. It was found "on basalt cliffs at Godhavn" (Lange, 1880). It is known also from Scandinavia and the high mountains of northern Russia.

Hylocomium splendens (Hedw.) BSG. Collected many times: Carlo, Kantishna, Lagoon, Triple L., and Wonder L. Two specimens collected at Kantishna, A4 and C17, and one from Wonder L., B27, are nearest to the reduced arctic form which Kindberg called *H. alaskanum*.

Hypnum callichroum Brid. (*det.* Andrews). Wonder L., on soil in open tundra, B19.

H. crista-castrensis Hedw. Carlo, on leaf mold in white spruce and willow grove, C23. Kantishna, thin soil over rock, dry, exposed, A64. Wonder L., ground cover under *Betula glandulosa* and *Ledum*, A39, B8; on rotting wood in alder thicket, B7; on moist soil of pot-hole A46.

H. cupressiforme Hedw. Horseshoe L., on soil of rocky slope, A36 (*det.* Persson). Kantishna, on schist, A4 (*det.* Crum); in cracks of disintegrating schist, A42 (*det.* Andrews).

H. lindbergii Mitt. Wonder L., on *Vaccinium* leaf mold, A68. Another specimen (no. A71), growing on wet soil and gravel at Wonder Lake, can be referred to **H. lindbergii** var. **elatum** (Schimp.) n. comb. (*H. arcuatum* var. *elatum* Schimp., Syn. Musc. Eur. Ed. 2. 758. 1876).

H. subplicatile (Lindb.) Limpr. Riley Creek, ground cover of forest floor, C49 (*det.* Andrews). Wonder L., on moist soil in pot-hole with *Scapania curta* and other hepatics, A38.

***H. vaucheri* var. *coelophyllum* Mol. (*det.* Persson). Kantishna, on schist, dry exposed, with *Leskea nervosa* and ten other mosses, A4. "This variety which, perhaps, would best be treated as a modification is known previously only from Switzerland" (Persson, *in lit.*).

Leptobryum pyriforme (Hedw.) Schimp. Carlo, B33. Kantishna, C24. Horseshoe L., C37, C40. Triple L., B38, B25, C7. Wonder L., B56.

***Leskea nervosa* (Schw.) Myr. (*det.* Crum). Kantishna, on schist, dry, exposed, with *Hypnum vaucheri* var. *coelophyllum* and ten other mosses and hepatics, A4. Steere (1947) says that it is evidently rare in the Canadian Eastern Arctic; it is recorded only once from Ellesmere Island

(76° 25′ N. Lat.), by Bryhn (1906). A circumboreal species, widespread in northern America extending from Ellesmere to British Columbia, south to Pennsylvania and Colorado; throughout the mountains of Europe and Asia.

**Meesia triquetra* (Hook. & Tayl.) Ängstr. (*det.* Andrews). Wonder L., bank of marshy pool, B68. Known from Central Pacific Coast and Arctic Coast (Persson, 1952a); Central Yukon River (Sherrard, 1955). Williams (1901) reported it from the Klondike River.

M. uliginosa ad var. *minor* (Brid.) BSG. Polychrome Pass, on *Dryas* sod, with *Catoscopium nigritum*, S5.

**Mnium cuspidatum* Hedw. Carlo (a few plants only) on bank of stream in partial shade, C50. Listed for Eastern Pacific Coast and Central Yukon River (Harvill, 1950); Eastern and Western Pacific Coast (Persson, 1954).

M. orthorhynchum Brid. Horseshoe L., on trunk of white spruce, C37 (*det.* Persson). Kantishna, on schist, C16 (*det.* Crum); on soil in shade, A3, B32.

**M. pseudopunctatum* Br. & Sch. (*det.* Persson). Wonder L., wet soil in depression, A67. There are many records for this circumboreal species from Oceanic Alaska including the Aleutian Islands. It is known also from Bering Sea (Cardot & Thériot, 1902; Merriam, 1892; Arnell, 1917) and listed from Bering Sea, Bering Strait, Arctic Coast, Central Yukon River (Persson, 1947).

M. punctatum Hedw. (*det.* Andrews). Wonder L., on mud, moist bank of marshy pool, B67. (Persson feels that this specimen can be assigned to the often-segregated species, *M. pseudopunctatum*.)

**M. rugicum* Laur. (*det.* Persson). Kantishna, on shale and leaf mold of water-saturated bank, B64. A circumpolar species common in the inner and northern parts of Alaska but rare along the coast (Persson, 1947).

**Myurella julacea* (Schw.) BSG. Horseshoe L., on alder stump, C40. A subalpine moss known in Alaska from Eastern Pacific Coast (Persson, 1947); Central Pacific Coast (Cardot & Thériot, 1902); Western Pacific Coast and Aleutian Islands (Bartram, 1938); Central Yukon River (Harvill, 1948; Sherrard, 1955); Yukon Territory and British Columbia (Williams, 1901).

Oligotrichum hercynicum (Hedw.) Lam. & DeCand. (*det.* Persson). Wonder L., on newly broken ground, B16.

**O. laevigatum* var. *cavifolium* (Wils.) Frye. (*det.* Andrews). Kantishna, on moist soil of shaley bank, B51.

Oncophorus virens (Hedw.) Brid. Garner, on mud in pot-hole, B1. Wonder L., wet soil, C52 (*det.* Steere); saturated mud, A17.

Paludella squarrosa (Hedw.) Brid. Triple L., on mud, partly submerged, C20. Wonder L., in stagnant pool, A61.

Philonotis tomentella Mol. [*P. fontana* var. *pumila* Brid.; *P. alpicola* Jur.] (*det.* Persson). Kantishna, on saturated shaley bank, B64. Wonder L., in ditch on gravel beach, A1, *c. fr.* This circumboreal, arctic-alpine moss is the common *Philonotis* in the mountains of Alaska (Persson *in lit.*)

and "by far the most common and widely distributed species of *Philonotis* in the Canadian Eastern Arctic" (Steere, 1947).

**Plagiothecium pulchellum* (Hedw.) BSG. [*Isopterygium pulchellum* (Hedw.) Broth.]. Triple L., on soil, C42 (*det.* Crum); on loamy soil, B38 (*det.* Persson). Recorded by Persson (1954) from Central Pacific Coast, Bering Strait, Arctic Coast and Central Yukon River. Recorded also for the latter district by Sherrard (1955). Grout (1928) cited it as "rare but frequent in parts of British Columbia."

Pogonatum alpinum (Hedw.) Röhl. Kantishna, on shaley bank, a few plants only with *Oligotrichum laevigatum* v. *cavifolium*, B51.

P. capillare (Mx.) Brid. Wonder L., on newly broken ground, B17; on gravel, A47; moist soil of pot-hole, B45.

P. urnigerum (Hedw.) P-B. Wonder L., on newly disturbed ground, A48.

Pohlia annotina (Hedw.) Loeske. Wonder L., on wet soils in pot-holes, B27, B29.

***P. columbica* (Kindb.) Andrews [*Webera columbica* Kindb.] (*det.* Persson). Kantishna, on moist gravel, growing profusely, old setae reddish orange, A75, *c. fr.* Known previously from British Columbia where it is not uncommon. J. Macoun (1892) collected this species in the Selkirk Mts., Revelstoke, Hastings and several other localities in the region. Recently it has been recorded from Japan (Ochi, 1956).

P. cruda (Hedw.) Lindb. Kantishna, on sandy bank formed by flood water, C24. Triple L., moist soil, B38 (*det.* Persson).

**P. drummondii* (C. M.) Andrews. Kantishna, moist soil of upland tundra, A3 (*det.* Andrews). Polychrome Pass, on stream bed, M10 (*det.* Persson). Previous records are from Eastern Pacific Coast (Lesquereux & James, 1884; Holzinger & Frye, 1921). Known also from Yukon-British Columbia boundary (Williams, 1901).

P. nutans (Hedw.) Lindb. Garner, C36. Kantishna, B44. Triple L., C26. Wonder L., B67, B42, A8.

P. proligera Lindb. Kantishna, on stones and mud in creek bed, B44.

P. wahlenbergii (Web. & Mohr) Andrews. Kantishna, on grass, B14; on moist soil of shaley banks, B50; on rocks and leaf mold, B64 (*det.* Persson).

Polytrichum commune Hedw. Kantishna, on recently broken soil and grass, A12. Triple L., moist bank, covering large area, C31. Wonder L., on soil under grass, A8.

P. juniperinum Hedw. Carlo, Kantishna, Triple L., Wonder L. 10 collections.

P. piliferum Hedw. Garner, hard ground of wind-swept upland tundra, C36. Kantishna, recently broken soil, A12. Wonder L., in cracks of disintegrating schist, A42; on dry, stump, C55.

Pylaisia polyantha BSG. Kantishna, on dead wood in alder thicket, C1.

Rhacomitrium canescens Brid. Kantishna, on schist, A2. Var. *ericoides* (Brid.) Moenk. Cathedral Mt., B21. Kantishna, B69, C16. Wonder L., C54, on alpine slopes or rock outcrops on upland tundra.

R. lanuginosum (Hedw.) Brid. Cathedral Mt., exposed alpine slope, B21. Kantishna, on schist, A4, C54. Wonder L., newly broken ground, B16.

Rhytidiadelphus triquetrus (Hedw.) Warnst. Garner, on leaf mold in aspen grove, A44.

Rhytidium rugosum (Hedw.) Lindb. Garner, Kantishna, Wonder L., found about 15 times mostly in small quantities and always in mixture with other mosses.

Scorpidium scorpioides (Hedw.) Limpr. (*det.* Persson). Lagoon, submerged, B11.

Sphagnum capillaceum (Weiss) Schrank. Wonder L., on loam in pothole, A16. Var. *tenellum* (Schimp.) Andrews. Triple L., mud in stagnant pool, C20; Wonder L., in alder thicket on highland tundra, A59.

**S. fuscum* (Schimp.) Kling. Wonder L., saturated soil at edge of tarn, A70. A circumboreal species known from Eastern Pacific Coast (Holzinger & Frye, 1921); Bering Sea (Setchell, 1907); Bering Strait (Arnell, 1917); Arctic Coast (Harvill, 1948); Central Yukon River (Williams, 1901; Harvill, 1948; Sherrard, 1955).

S. girgensohnii Russ. Wonder L., on soil in pot-hole with *Hypnum suplicatile* and hepatics, A38; prolific ground cover with *H. crista-castrensis*, A39; edge of tarn with *Eriophorum*, A76.

S. lindbergii Schimp. Wonder L., edge of pot-hole, A7.

S. squarrosum Crome. Wonder L., in pool with *Drepanocladus aduncus*, A18.

Splachnum luteum Hedw. Polychrome Pass, moist soil on camp floor, S12.

**Tetraplodon angustatus* (Hedw.) BSG. Wonder L., on moist soil under grass, C22. Earlier records are from Central Yukon River (Persson, 1954; Sherrard, 1955); Yukon Territory (Williams, 1901).

T. mnioides (Hedw.) BSG. Triple L., on twigs and decaying matter in white spruce grove, C5. Wonder L., moist soil under grass, C22.

T. urceolatus (Brid.) BSG. Kantishna, exposed on soil, B61. Wonder L., moist soil under grass, C22.

Thuidium abietinum (Brid.) BSG. Garner, Kantishna, Wonder L., on rock, leaf mold or trees, A2, B4, B9, C14.

Timmia austriaca Hedw. Carlo, on silt, bank of Nenana River, C34.

**T. norvegica* Zett. Kantishna, a few plants only found with *Pohlia columbica*, on moist gravel, A75. This circumboreal species, rare in northern America, is recorded in Alaska from Bering Strait (Arnell, 1917); Arctic Alaska (Steere, 1954); Central Yukon River (Sherrard, 1955).

Tortula ruralis (Hedw.) Sm. Kantishna, on schist, C54; on disintegrating mica schist, A2, A4 (*det.* Persson).

Hepaticae

**Anthelia julacea* (L.) Dum. (*det.* Andrews). Wonder L., a few plants only found with *Pleuroclada albescens* and other hepatics, on mud in pothole, B45. A nearctic species reported from Eastern and Western Pacific Coasts (Eyerdam, 1952); Central Pacific Coast (Evans, 1900, 1914; Eyerdam, 1952); Bering Sea (Evans, 1900; Clark & Frye, 1949); Aleutian

Islands (Clark & Frye, 1948 and 1949; Evans, 1901); Arctic Alaska (Steere, 1954). It has been found at Katmai on volcanic ash (Griggs, 1933).

**Blasia pusilla* L. Kantishna, on sandy bank formed by flood water, shade, C11. The two earlier Alaskan reports are Eastern Pacific Coast (Evans, 1900); Aleutian Islands (Clark & Frye, 1948). It was collected by Hultén from Kamtschatka (Arnell, 1927).

Blepharostoma trichophyllum (L.) Dum. Carlo, on bank of mountain stream, B31. Kantishna, moist soil of upland tunda, A3. Wonder L., on clay bank of alder and willow grove, B65.

**Cephalozia ambigua* Mass. Kantishna, on wet silt and mica schist of creek bed, A25, with perianths. Known from Eastern and Western Pacific Coasts (Persson, 1946); Central Pacific Coast (Eyerdam, 1952).

**C. connivens* (Dicks.) Lindb. Wonder L., exposed on bank of pot-hole, B66. Recorded only from Central Pacific Coast (Clark & Frye, 1942; Eyerdam, 1952).

C. pleniceps (Aust.) Lindb. Kantishna, on mud and stones of creek bed, B44. Wonder L., on mud bank of pool, B60.

**Gymnocolea inflata* (Huds.) Dum. (*leg.* G. Murie). Summit of Polychrome Pass, on rock outcrops of alpine slope with *Conostomum boreale*, B24. Known from Eastern Pacific Coast (Evans, 1914); Central Pacific Coast (Clark & Frye, 1942); Western Pacific Coast (Evans, 1900); Bering Sea (Evans, 1901).

**Jungermannia sphaerocarpa* Hook. Wonder L., on mud in pot-hole, B27. Earlier records are Eastern Pacific Coast and Bering Strait (Evans, 1900); Western Pacific Coast (Griggs, 1933); Aleutian Islands (Clark & Frye, 1948); Bering Sea (Persson, 1952).

**Leiocolea heterocolpa* (Thed.) Buch (*det.* Persson). Wonder L., on clay bank in willow and alder grove with *Fissidens adiantoides*, B65. Reported by Persson (1952) from Eastern & Central Pacific Coasts, Aleutian Islands and Central Yukon River. Other records are Central Pacific Coast (Evans, 1900); Yukon Territory (Howe, 1901).

L. rutheana (Limpr.) Evans [*L. schultzii* (N.) Jorg.] (*det.* Andrews). Wonder L., on bank of pot-hole (one plant only) with *Dicranum groenlandicum* and other mosses and hepatics, B66; on saturated soil in depression, A66.

**Lophozia alpestris* (Schleich.) Evans (*det.* Andrews). Wonder L., on wet soil of pot-hole (a few plants only) with *Pogonatum capillare* and several hepatics, B45. This species is recorded from all Alaskan floristic divisions except Arctic Coast and Upper Yukon River. It is also known from British Columbia (Brinkman, 1934).

L. ventricosa (Dicks.) Dum. (*det.* Andrews). Wonder L., on moist soil of upland tundra, C3.

Marchantia polymorpha L. Carlo, on silt, Nenana River, C34. Horseshoe L., in shade, on thin soil of rocky slope, A36. Wonder L., on moist soil and gravel, B57, B47.

Marsupella emarginata (Ehrh.) Dum. Carlo, bank of mountain stream, B31. Wonder L., clay bank in alder and willow grove, B65.

**Nardia scalaris* (Schrad.) F. S. Gray (*det.* Andrews). Wonder L., on soil with *Pogonatum capillare*, B45, B39. Earlier records are Eastern, Central and Western Pacific Coasts (Evans, 1914; Clark & Frye, 1942); Aleutian Islands (Clark & Frye, 1946 and 1948); Yukon Territory (Howe, 1901). Two other records are Eastern and Western Pacific Coasts (Evans, 1900, and Griggs, 1933, respectively).

Pleuroclada albescens (Hook.) Spr. (*det.* Andrews). Wonder L., on wet soil in pot-hole, B45.

**Preissia quadrata* (Scop.) Nees. Horseshoe L., on alder stump, C37, C40. Kantishna, on sandy soil formed by flood water, A45. A nearctic species reported from several localities in Oceanic Alaska (Evans, 1900 and 1914; Clark & Frye, 1949; Eyerdam, 1952). Known also from Aleutian Islands and Bering Strait (Clark & Frye, 1942); Yukon Territory (Evans, 1900; Brinkman, 1934).

Ptilidium ciliare (L.) Nees. Carlo, on soil in birch muskeg, C44. Not abundant in the region.

P. pulcherrimum (Web.) Hampe (*det.* Crum). Garner, on thin soil over rock in aspen grove, E6. Wonder L., on live white spruce, B48.

**Riccardia pinguis* (L.) S. F. Gray. Horseshoe L., on a few plants only collected with *Drepanocladus uncinatus* and other mosses and hepatics on thin soil of rocky slope, A36. Listed from Eastern Pacific Coast (Evans, 1900); Central Pacific Coast (Eyerdam, 1952); Aleutian Islands (Clark & Frye, 1948); Yukon Territory (Brinkman, 1934).

**Scapania curta* (Mart.) Dum. (*det.* Clark). Wonder L., on wet soil of pot-hole, A38. Eastern Pacific Coast (Evans, 1900; Stair, 1947a); Central Pacific Coast (Eyerdam, 1952); Western Pacific Coast (Clark & Frye, 1942); Aleutian Islands (Clark & Frye, 1948; Evans, 1901); Bering Sea (Persson, 1952).

**S. irrigua* (Nees) Dum. Wonder L., on mud of pot-hole, B27. Listed for Eastern Pacific Coast (Stair, 1947a); Central Pacific Coast and Aleutian Islands (Persson, 1952); Western Pacific Coast (Evans, 1914; Clark & Frye, 1942; Persson, 1952); Bering Sea (Müller, 1905; Persson, 1952); Bering Strait (Evans, 1900).

**S. paludicola* Loeske & K. M. (*det.* Persson). Wonder L., on wet soils in depressions, A66, A67, B42, B67. Listed by Persson (1952) from Central and Western Pacific Coasts, Bering Sea, Arctic Coast and Central Yukon River. Eyerdam (1952) adds records from Central Pacific Coast and Aleutian Islands, and Evans (1916) from Bering Strait.

Sphenolobus minutus (Crantz) Steph. Wonder L., on wet soil of pot-hole, A38. A nearctic species recorded from all Alaskan floristic divisions except Lower Yukon River (Persson, 1952).

**Temnoma setiforme* (Ehrh.) Howe. Carlo, on rocks, A56. Listed for Central Pacific Coast (Persson, 1952); Bering Sea (Evans, 1900; Arnell, 1917; Persson, 1952); Bering Strait (Steere, 1938; Clark & Frye, 1942); Central Yukon River (Evans, 1903); British Columbia (Howe, 1901).

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THE FIRST RECORD OF GOLLANIA IN NORTH AMERICA

HISATSUGU ANDO, HERMAN PERSSON AND ELIZABETH M. SHERRARD[1, 2]

The close relationship between the floras of eastern Asia and western North America is again emphasized by the recent discovery of *Gollania densepinnata* Dix. in Alaska. This species, previously known only from China (Dixon, 1928), was found in the Mt. McKinley region in 1951. On July 15, in the unglaciated

[1] Field work done under the auspices of the Arctic Institute of North America with funds provided by the Office of Naval Research.

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area of Kantishna, 30 miles northwest of Mt. McKinley, Mrs. Sherrard collected a moss which for some time puzzled various bryologists. Mrs. Ethel P. Hutchinson of Canaan, N. H., and Mrs. Sherrard, who worked on the Mt. McKinley collection, were unable to determine the specimen and sent it to a leading bryologist for his opinion. He noted some resemblance between the leaf structure and that of *Rhytidiadelphus triquetrus* but was not sure that the specimen belonged there and suggested that Dr. Persson's opinion be asked. The latter thought that it might be a *Gollania,* a genus not previously known in North America. After comparing the specimen unsuccessfully with 17 species of *Gollania* in the herbarium at Stockholm, he provisionally called it *Gollania alaskana* H. Perss. *in lit.* But since he was familiar with the genus only through collecting *G. berthelotiana* (Mont.) Broth. in Madeira and the Azores, he sent the Alaskan puzzle to still another bryologist. This authority determined the specimen as *Hypnum plumaeforme* Wils., an eastern Asiatic species rather common in Japan, Korea, Formosa, Indo-China and China, where it seems to replace the widely distributed *H. cupressiforme* Hedw. (It is also known from the Philippines. The Stockholm herbarium has a specimen named by Brotherus and recently confirmed by E. B. Bartram; the packet, originally in the herbarium of T. Suse, is labeled "*Stereodon,* Philippinen, *leg.* Schneider 1910.")

After examining 40 specimens of *H. plumaeforme* in the Stockholm herbarium, Dr. Persson was not convinced that the Alaskan moss belonged to that species, although he found a similar specimen named *Stereodon plumaeformis* (Wils.) Broth. by C. Müller; it was collected in August 1896 by Rev. Giraldi (no. 2081) in "China interior, provincia Schensi septentr. in monte Thae-persan."

Late in 1956 Mrs. Sherrard wrote Dr. Persson that she had been in correspondence with H. Ando regarding the distribution of *H. plumaeforme* in Japan and that she had sent him a sample of the Alaskan moss labeled *H. plumaeforme* but with no mention of its determination as *Gollania.* Ando wrote her that, in his opinion, the moss was not a *Hypnum* but rather a species of *Gollania* unknown to him. Ando and Persson have since studied the literature and examined many specimens of *Gollania* and have found that the Alaskan plant fits the description of *Gollania densepinnata* Dix. (1928), a species originally collected in Shensi, China, "entre Teou mou kong et Fang yang soeu, 2,700 m. alt., 6/9/16 (125, 126)" by Rev. Père E. Licent. A comparison with the type (kindly lent by the British Museum) has confirmed the matter. It was also found that the aforementioned specimen named

Hypnum plumaeforme and collected by Giraldi in northern China also belongs to *Gollania densepinnata*. Accordingly, the species is now known from two localities in Shensi and one in Alaska.

Ecology

Gollania densepinnata grew on schist in an extremely dry, exposed location on the north face of the tor above the saddle along the trail to Little Annie Mine, Quigley Hill, Kantishna, Alaska, 63° 33′ N, 150° 56′ W, at an altitude of 2960 ft. (*Sherrard* C16). It was associated with *Mnium orthorhynchum, Rhacomitrium canescens* var. *ericoides, Distichium capillaceum, Grimmia apocarpa, Ditrichum flexicaule, Cirriphyllum cirrosum* and *Saxifraga oppositifolia*.

The Kantishna region embraces all the northern slope of the Alaska range from the Nenana River westward to and including the headward basin of the Kantishna River (Capps, 1940). In this region the great mountain arc of the Alaska Range, which extends through central Alaska, culminates at its crest in Mt. McKinley, the loftiest peak on the continent. It was 30 miles directly north of Mt. McKinley in the once-active gold mining town of Kantishna that the *Gollania* was collected. The tor on Quigley Hill where it was found stands between two small creeks, Eureka Creek and Friday Creek, both famous for their gold placers. At Kantishna they enter the swift-flowing Moose Creek, which drains through the Kantishna, Tanana and Yukon Rivers into the Bering Sea.

The bedrock of the Kantishna region is Birch Creek Schist. This formation has two distinct facies: a quartz-muscovite schist and a calcareous schist ranging from limestone to chlorite schist (Wells, 1933). Quigley Hill is composed predominantly of limestone and chlorite schist and is part of the discontinuous outcroppings of metamorphosed calcareous sediments characteristic of the area (*ibid.*). On the weathered surface the foliation planes alternate with thin lenses of granular material.

The name "Birch Creek Schist" was first used by Spurr (1898) for a group of rocks found in a tributary of the Yukon, and was applied by Brooks and Prindle (Brooks, 1911) to the metamorphic rocks in the Kantishna region on the basis of similar characteristics. There is no positive evidence of the age of these schists, but Mertie (1930) classified them as early pre-Cambrian.

It is believed that the Kantishna region and the northern foothills of the Alaska Range have remained comparatively unglaciated. The development of Pleistocene glaciers on the north slope of the Alaska Range was more moderate than on the southern slope,

and few of the northward-flowing glaciers pushed their fronts beyond the base of the foothills. It is known, however, that at some time the Muldrow Glacier, the largest on the northern slopes, pushed northward beyond its present terminus and sent several ice lobes down Moose Creek. Glacial erratics have been found in Eureka and Friday Creeks as high as the 2000-ft. contour (Wells, 1933).

Kellogg & Nygard (1951) classified the soils of the Kantishna area as lithosols. These are azonal soils that consist mainly of hard rock with or without thin irregular coverings of soil materials. "The geological material of azonal soils as been altered so little that their characteristics are essentially those of the geological deposit itself" (*ibid.*). The vegetation of Quigley Hill is similar to that supported by alpine meadow soils. The predominant flowering plants on the tor are *Saxifraga oppositifolia, Dryas* sp., *Salix reticulata, Silene acaulis* var. *exscapa* and *Zygadenus elegans.* On the lower slopes the plants are *Cassiope tetragona, Habenaria hyperborea, Castilleja* and *Boschniakia* spp. Lichens are abundant; *Blastenia tetraspora* (*det.* J. W. Thomson), a rare species apparently new to Alaska, was found growing on the tor with *Grimmia apocarpa* var. *gracilis.*

There is no weather station within the Kantishna-Eureka area, but records from the weather bureau at McKinley Park Headquarters, approximately 90 miles to the west, may serve as a basis for some general statements about the climate of the region. These records, obtained over the last 30 years, show wide extremes in temperature, 89° F. and −51° F., and a total annual precipitation varying from 8.45 in. to 22.66 in. The mean monthly temperature of the growing season is 52.78° F. The entire Kantishna region is included by Kellogg and Nygard (1951) in the "discontinuous permafrost" zone, but no information on the specific Kantishna-Eureka Creek area is available. However, it is perhaps safe to say that, owing to the nearness of the bedrock to the surface and to the scant soil covering, this habitat is little effected by permafrost.

Taxonomy

In addition to his excellent description in Latin, Dixon (1928) characterized *Gollania densepinnata* as a "very distinct species in the compact, densely pinnate growth, with stereodontoid leaf-form and direction but with sharply toothed leaves, the alar group of cells distinct, and the geminate nerves, separated, not united at base, well defined and reaching rather high in the leaf. *G. necker-*

ella has different growth and foliation, wider leaf base, more strongly toothed acumen, less distinct nerves, etc." He also emphasized the hypnoid appearance in his formal description as "habitu formis robustioribus Stereodontis imponentis subsimile." The following detailed description includes the sporophyte which was unknown to Dixon:

Dioicous? Plants moderately robust, densely caespitose, rigid and fragile, golden-yellow to golden-brown, somewhat glossy. Stems prostrate, yellow to dark brown, with few rhizoids; in cross-section cortical cells in 3-4 layers, with thickened walls, medullary cells larger, with thinner walls sometimes pitted, central strand slightly developed. Branching regularly and very closely pinnate; branches weakly complanate, spreading or ascending, sometimes curved, sometimes subjulaceous, 3-7 (10) mm. long, usually uneven in length. Paraphyllia rare, lanceolate. Stem leaves closely imbricate, lance-ovate to oblong-ovate, falcate, gradually short-acuminate, not decurrent, 600-800 μ wide and 2200-2500 μ long, plicate and slightly rugose; acumen more or less serrulate; margins strongly recurved along the lower half and sometimes also along part of the acumen; costae two, separate at base, nearly parallel, distinct, rarely reaching midleaf; median cells with thickened walls, smooth, the lumen 40-50 (60) μ long and 2 μ wide; basal cells more thickened and porose; angular cells well differentiated, numerous, quadrate to polygonal. Branch leaves smaller, 400-550 μ wide and 1500-1800 μ long, oblong-lanceolate, gradually narrowed toward the base; alar cells slightly differentiated; other characteristics almost the same as in the stem leaves.

Inner perichaetial leaves lanceolate, somewhat suddenly long-acuminate, not or slightly plicate; acumen slightly serrulate or almost entire; costa distinct, extending more than half-way up. Seta reddish-brown, smooth, about 22 mm. long, twisted to the right below and to the left above on drying. Capsule oblique, yellowish-brown, oblong-cylindric, 0.55 mm. thick and 2.7 mm. long including the rostellate operculum; annulus 2-seriate. (*Fig.* 1-13.)

The most characteristic features of *Gollania densepinnata* are the densely pinnate, *Hypnum*-like growth, the golden-brown color (common in the genus), the very falcate leaves, not much striate or rugose, the strongly recurved and moderately dentate leaf margins, the long, distinct double nerve, the unusually thick cell walls without papillae (which are found rather commonly in the genus), as well as the small alar cells. It is of interest to note that *Gollania densepinnata* has a slightly developed central strand, although Brotherus (1925), in the generic description, stated

"Stengel ohne Zentralstrang" (but characterized the family Rhytidiaceae as "meist mit undeutlichem Zentralstrang"). It is possible, however, to find a poorly developed central strand in other species of *Gollania* as well.

As shown above, Dixon emphasized the resemblance of *Gollania densepinnata* to *Hypnum*, and it is not surprising that two leading taxonomists, at different times, have referred it to *Hypnum plumaeforme*. The habit and the falcate leaf form, not to mention the fact that the leaves are much less rugose than usual in *Gollania* (in fact the upper leaves are not rugose at all and the lower not very much), makes it only too easy to mistake this species for a *Hypnum*. It is true that most species of *Hypnum* other than *H. plumaeforme* have leaves less strongly dentate than in *Gollania densepinnata* and most other members of that genus. Aside from its slight rugosity of leaves *Gollania densepinnata* is distinguished from *Hypnum plumaeforme* by the markedly recurved leaf margin (which in the *Hypnum* is plane) and also by the better-developed area of quadrate alar cells.

Dixon compared his *Gollania* only with *G. neckerella* (also from Shensi). We have found it to be still closer to two other species, namely *G. clarescens* (Wils.) Broth. from Himalava and *G. hylocomioides* Broth. *ms.* from northwestern Yunnan (*Handel-Mazzetti* 6798; see Brotherus, 1929a). Indeed, in the form and some other characteristics of the leaves *G. densepinnata* is strikingly similar especially to *G. hylocomioides*, which however has leaves more rugose, less falcate and much more dentate; in *G. clarescens* the leaf margin seems less strongly recurved, the nerve shorter and the cell-walls of the leaves considerably thinner. And last but not least, the habits of the two latter species are so strikingly unlike that of *G. densepinnata* that there can be no doubt that these three species should be kept separate. (*G. hyloçomioides* is much like *Hylocomium splendens* in habit and particularly distinct from *G. densepinnata* in appearance.)

A Preliminary Revision of Gollania in Eastern Asia

The genus *Gollania* was established by Brotherus (1908) for nine species formerly placed in *Ctenidium, Eurhynchium, Hyocomium, Hypnum* and *Stereodon*. Later (1925) he included 13 species in the genus, and since then no less than 19 additional species have been established (some of them unpublished). We have seen all 32 species except for two from Africa and those from Amur and Lake Baikal.

In 1908 Brotherus included *Gollania* in the Hypnaceae sub-

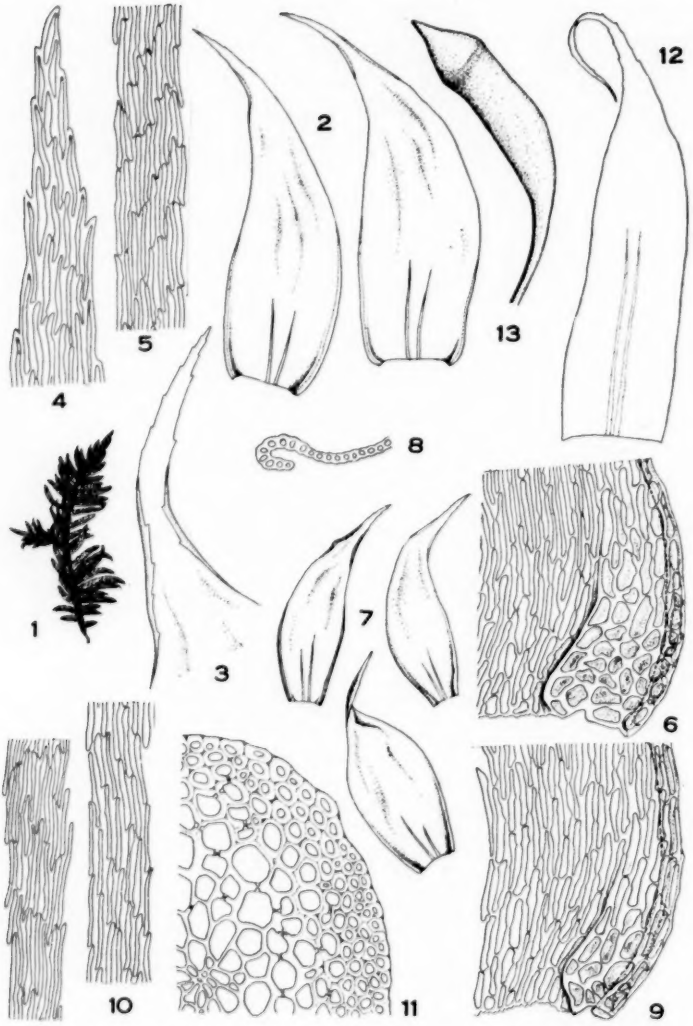

FIG. 1-13. *Gollania densepinnata*. 1. Plant, natural size. 2. Stem leaves, × 25. 3. Apex of stem leaf (dorsal view), × 64. 4. Apical cells of stem leaf, × 248. 5. Median cells of stem leaf, × 248. 6. Basal angle of stem leaf, × 248. 7. Branch leaves, × 25. 8. Cross section of branch leaf near base, at margin, × 248. 9. Basal angle of branch leaf, × 248. 10. Median cells of branch leaf, × 248. 11. Cross-section of stem, × 248. 12. Inner

family Hylocomieae. In 1925 he placed it in the Rhytidiaceae which had been established that year by Fleischer in his *Musci der Flora von Buitenzorg.* In this family he also included *Lesquereuxia, Loeskeobryum, Okamuraea, Ptychodium, Rhytidiadelphus, Rhytidiopsis* and *Rhytidium.* There have always been great taxonomic difficulties with respect to hypnaceous mosses, and practically each taxonomist has his own system. Recently Andrews (1954) discussed the relationship of the genera commonly included in the Rhytidiaceae. He summarized the results of his interesting study by saying that the genera placed there by Fleischer and Brotherus are of various relationships and are unnaturally grouped together. He concluded that there is no justification for keeping a family of that name. As to *Gollania,* he remarked that it shows enough similarity to *Ctenidium* in its leaf characteristics for probable inclusion in the Hypnaceae. On the whole we would agree with Andrews and especially as regards his estimation of the Rhytidaceae.

Of the 15 species which have been reported from Japan, Formosa and Korea, only eight proved (when studied by Ando) to be valid. These species are summarized as follows:

Gollania cochlearifolia Broth. *ex* Sakurai, Bot. Mag. Tokyo 53: 67. 1939. Japan; Formosa.

G. arisanensis Sakurai, Bot. Mag. Tokyo 46: 507. 1932. Formosa.

G. exaltata (Mitt.) Broth. *in* E. & P., Nat. Pfl. 1(3): 1055. 1908. Japan.

G. neckerella var. *coreensis* (Card.) Broth., *Ibid.* Japan; Korea.

G. ruginosa (Mitt.) Broth., *Ibid. G. perundulata* Dix., Rev. Bryol. 13: 18. 1942. Japan; Himalaya; China (Brotherus, 1929a).

G. splendens (Broth.) Noguchi, Jour. Jap. Bot. 30: 144. 1955. *G. subcochlearifolia* Dix., Rev. Bryol. 13: 17. 1942. Japan.

G. subtereticaulis Broth. & Yasuda, Bryol. 1: 26. 1928. Formosa.

G. varians (Mitt.) Broth. *in* E. & P., Nat. Pfl. 1(3): 1055. 1908. *G. mayri* (Broth.), *Ibid.; G. macrothamnioides* Broth., Öv. Finska Vet.-Soc. Förh. 62: 38. 1919-20; *G. sasaokae* Broth., Ann. Bryol. 1: 26. 1928. Japan.

G. bipinnata Dix. (Rev. Bryol. 13: 17. 1942) is a synonym of *Heterophyllium brachycarpum* (Mitt.) Fl. (isotype seen). *G. rhynchostegioides* Dix. & Thér. (Rev. Bryol. 13: 18. 1942) is a synonym of *Dolichotheca perrobusta* (Broth.) Broth. (isotype seen). *G. tereticaulis* Broth. (*in* Handel-Mazzetti, Symb. Sinica 4: 129. 1929) can be referred to *Erythrodontium.*

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perichaetial leaf, × 51. 13. Capsule, × 25. (All figures drawn by Ando; fig. 1-11 from Sherrard's Alaskan collection; fig. 12-13 from Giraldi's no. 2081 from China.)

Thus six species are known from Japan (three endemic), three from Formosa and one from Korea. Although further reductions may be in order when the species from other areas are studied, we can, without doubt, state that the center of the genus is in the Far East. From China we know eight species all apparently endemic (except for *G. densepinnata*, also in Alaska and *G. ruginosa*, also in Himalayas and Japan) and from Amur one endemic. Other Asiatic occurrences are Lake Baikal one (endemic), the West Himalayas two (one of them endemic), Bhotan one (endemic), Java and the Philippines one each (endemic). Except in Alaska *Gollania* is unknown from America, as well as from Australia, New Zealand and the Pacific Islands. From Africa three endemic species are known: one in the Canary Islands, Madeira and the Azores, and one each in Gabon and the Belgian Congo. The two latter species just reach the equator; the Javan species is found a little south of the equator; all the other species grow in the northern hemisphere.

The distribution of the genus is shown in Figure 14. The abundance of endemics and the limited area occupied by most of the species indicate a genus of antiquity. A striking feature, also pointing the same way, is that all the species seem to grow in unglaciated regions. No doubt a further study of them and their relationship with one another would be of considerable interest.

Ecologically, the species of *Gollania* are all montane and generally occur in rocks and soil, but occasionally also on trunks of

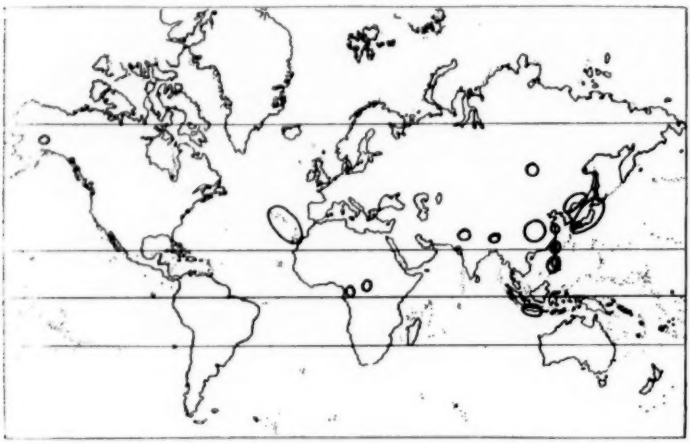

FIG. 14. The world distribution of the genus *Gollania*.

trees and on decayed logs. The Japanese species are found at a lowest altitude of 300 m. and a highest of 1900 m. Of the Chinese species the five species found in Yunnan are found between 2050 and 3400 m. *Gollania elberti* in Java grows at 2100 to 2500 m., and the Macaronesian *G. berthelotiana* is most abundant at an altitude of about 1000 m., descending to about 600 m. or a little lower.

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A NEW SPECIES AND A NEW COMBINATION OF CALYMPERES[1]

WILLIAM D. REESE[2]

During the course of a taxonomic revision of the North American species of *Calymperes* one new species was recognized and

[1] This work was supported by two consecutive predoctoral fellowships from the National Science Foundation and represents part of a doctoral dissertation completed in the Dept. of Biological Sciences, Florida State University, Tallahassee.

[2] Dept. of Biology, Southwestern Louisiana Institute, Lafayette, La.

one new combination was made. They are presented here in advance of the publication of the complete revision. An illustration of the new species will be published with the revision.

Calymperes (Hyophilina) **meyeri** n. sp. Plantae humiles, laxe gregariae, flavo-virides, circa 3 mm. altitudine. Folia 2.5-3 (—3.5) mm. longitudine, circa 0.5 mm. latitudine; lamina superior latior supra medium, oblanceolata vel elliptica e basi vaginante, supra basin constricta, apice obtusa, basi cuneata, marginibus e basi usque ad medium foliae denticulatis, e medio usque ad apicem serratis vel dentatis. Cancellinae elongatae, apicibus acutae, cellulis circa 8-seriatis. Costa valida, 50-60 μ latitudine prope apices cancellinarum, dorso infra laevis, supra papillosa, ventro papillosa. Cellulae rotundo-quadratae vel oblongae, 5 × 5-6 (–8) μ, dorso minute papillosae, ventro mammilloso-papillosae. Teniolae margines basilares formantes, distinctae vel indistinctae, flavidae, cellulis 2-4-seriatis. Fructus ignotus.

Tree trunk (growing with *Calymperes donnellii*), Barro Colorado Island, Panama Canal Zone, *S. L. Meyer* 7, 21 July, 1944. TYPE (*in herb.* University of Tennessee).

Calymperes meyeri, named in honor of Dr. S. L. Meyer, who collected the type, cannot be confused with any other North American *Calymperes* by reason of the marginal teniolae at the leaf base and for the same reason it is readily distinguished from small forms of *Syrrhopodon incompletus* Schwaegr., which it somewhat resembles. It is close to *Calymperes galliotii* Broth. & Par. from French Guiana but differs in its larger cells which are more or less papillose ventrally and in its margins which are not winged. *C. meyeri* superficially resembles *C. smithii* Bartr. from British Guiana but may be distinguished from it at first glance because of the very prominent shoulders of the leaf base of the latter species. Known only from the type collection, *C. meyeri* is apparently a rather uncommon species since it was not found in any other collections from the the vicinity of the type locality.

Calymperes venezuelanum (Mitt.) n. comb. *Syrrhopodon venezuelanus* Mitt., Jour. Linn. Soc. London, Bot. 12: 125. 1869. *Calymperes lonchophyllum* sensu R. S. Williams, Bull. Torrey Bot. Club 47: 393. 1920, p. p. *C. maguirei* Bartr., Bull. Torrey Bot. Club 75: 65. 1948.—The type of Mitten's *Syrrhopodon venezuelanus* was seen by Williams, who (1920) incorrectly placed the name in the synonymy of *C. lonchophyllum,* which it closely resembles. After Williams' work this species was collected in Dutch Guiana and was described by Bartram (1948) as *C. maguirei,*

named after its collector. Still later two collections of this species were made in the West Indies thus placing it in the North American area for the first time. A fifth collection, from "Guiana," bearing no other data except that it was from the herbarium of Montagne, was found under the name of *Calymperes lonchophyllum* in the Geneva Herbarium. All five collections agree perfectly in details of structure, and since Mitten's name is the oldest valid epithet for the species, the correct name becomes *C. venezuelanum* (Mitt.) Reese. This species is very distinct and not likely to be confused with any other except perhaps *C. lonchophyllum*. It may be distinguished immediately from the latter by its characteristically interrupted lamina and by the structure of the costa as seen in cross-section. It is apparently quite rare, having been collected only five times.

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REDISCOVERY OF SOLMSIELLA KURZII

PAUL L. REDFEARN, JR.[1]

In 1927 Dr. Herman Kurz of Florida State University collected from the bark of *Magnolia grandiflora* L. a small bryophyte which looked so like a liverwort that he sent it to Dr. A. W. Evans for identification. As it turned out this bryophyte was not a liverwort, but a moss belonging to the Erpodiaceae, and Steere (1934) proposed for it the name *Solmsiella kurzii*.

During the intervening years numerous attempts have been made by bryologists to collect this interesting endemic moss, but without success. Recently the author and Dr. Ronald A. Pursell made a third attempt to collect this species from the type locality and were successful because of a decision to collect all apparent members of the Lejeuneaceae growing on magnolia trees, since *S. kurzii* so closely resembles that family macroscopically One collection contained plants which were unusually dark green and

[1] Contribution from the Dept. of Biological Sciences, Florida State University, Tallahassee, Fla; Box 36, Southwest Missouri State College, Springfield, Mo.

except for their more loosely imbricated leaves, slightly smaller size, and lack of a brownish or purplish color in older leaves, looked very much like dry plants of *Mastigolejeunea auriculata* (Wils. & Hook.) Schiffn. Upon later examination in the laboratory these plants proved to be *S. kurzii*. They were widely scattered over the bark and certainly could be easily overlooked or passed by as juvenile forms of *M. auriculata*. The small size and rareness of *S. kurzii*, together with its resemblance to a common liverwort of this region, emphasize the possibility that, as pointed out by Steere, this species has a wider distribution than is presently known.

The locality in which *S. kurzii* occurs is a rich mesic woods bordering the northwestern shore of Lake Miccosukee in Jefferson County. This area is also noted for another endemic, *Grossularia echinella*, a gooseberry which was discovered by Kurz and Harper and described by Coville (1924). Harper (1925) has discussed the botany of this region and noted the richness of the deciduous forest as well as the aggregation of many unusual and interesting plants.

The recent collections of *S. kurzii* (*Redfearn* & *Pursell* 3195 and *Pursell, Redfearn* & *Breen* 2950) constitute topotypes. Duplicates of the former have been deposited in the herbaria of Florida State University and the University of Tennessee and a duplicate of the latter has been deposited in the Herbarium of the National Museum of Canada.

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BRYOPHYTES OF SASKATCHEWAN

Henry S. Conard[1]

This composite paper is attributed to one author to simplify bibliographic reference. The list is based on collections by Professor G. F. Ledingham of Regina College from the southern

[1] Lake Hamilton, Fla.; Visiting Professor in Botany, Drury College, Jan.-June 1957.

border of the Province to the vicinity of Regina, as well as at Saskatoon and Lac la Ronge; by LESLIE JENKINS mostly from near Saskatoon; by Ross WHEATON at Nesslin Lake; and about 500 collections by M. A. WELSH, Senior Sanitary Officer of the Department of Public Health, taken at Prince Albert and thence to the northern border of the Province, in areas accessible only by airplane. These collections are mostly from the Northern Coniferous Forest, on Pre-Cambrian rocks of the Canadian Shield. A collection from Devil's Lake and Otter Lake, northeast of Lac la Ronge, was made in August 1957 by Mr. SAM P. GUCCION of Cleveland, Ohio. Several names and localities were contributed by Dr. H. A. Crum of the National Museum of Canada. Most of the collections were made since 1950. Identifications are by H. S. Conard (who assumes all responsibility), with assistance from several experts. The collections are deposited at Prince Albert (*in herb.* M. A. Welsh), at Regina College, at the provincial Museum of Natural History, Regina, and at the State University of Iowa.

The map (*fig.* 1) is divided into numbered blocks by meridians and parallels. Numbers following the names of plants in the list indicate the blocks on the map in which the species have been collected. The absence of a number often indicates lack of collection rather than absence of the plants from that block. However the numbers also reveal geographic and ecologic limits of the plants. Our records refer to only 31 of the 44 blocks of the map. Blocks 18, 19, 27 and 41 are the best known bryologically, followed by 14, 23 and 43. When collecting has been done widely and well, a revised list will show geographic distributions of species and communities.

SASKATCHEWAN AS A HOME FOR MOSSES[2]

The 251,700 square miles and 880,000 people of Saskatchewan are included between 49° and 60° of north latitude and approximately 102° and 110° of west longitude. Lakes and streams cover 31,518 square miles. Though Saskatchewan is mostly a vast plain, the Cypress Hills of the southwest reach an altitude of 4546 feet above sea level. The lowest elevation in the Province is found at Lake Athabaska, 699 feet. The southern plains lie at three approximate levels: up to about 1100 feet in the east center of the Province; about 2000 feet in the south center; and up to 3100 feet farther southwest. In the north the low divide between the Mackenzie River basin and the Hudson Bay drainage reaches heights of 1300 to 1700 feet above sea level. Local relief may be about 200 feet.

[2] Edited and adapted from a manuscript by Mr. John Hudson of the Saskatchewan Research Council.

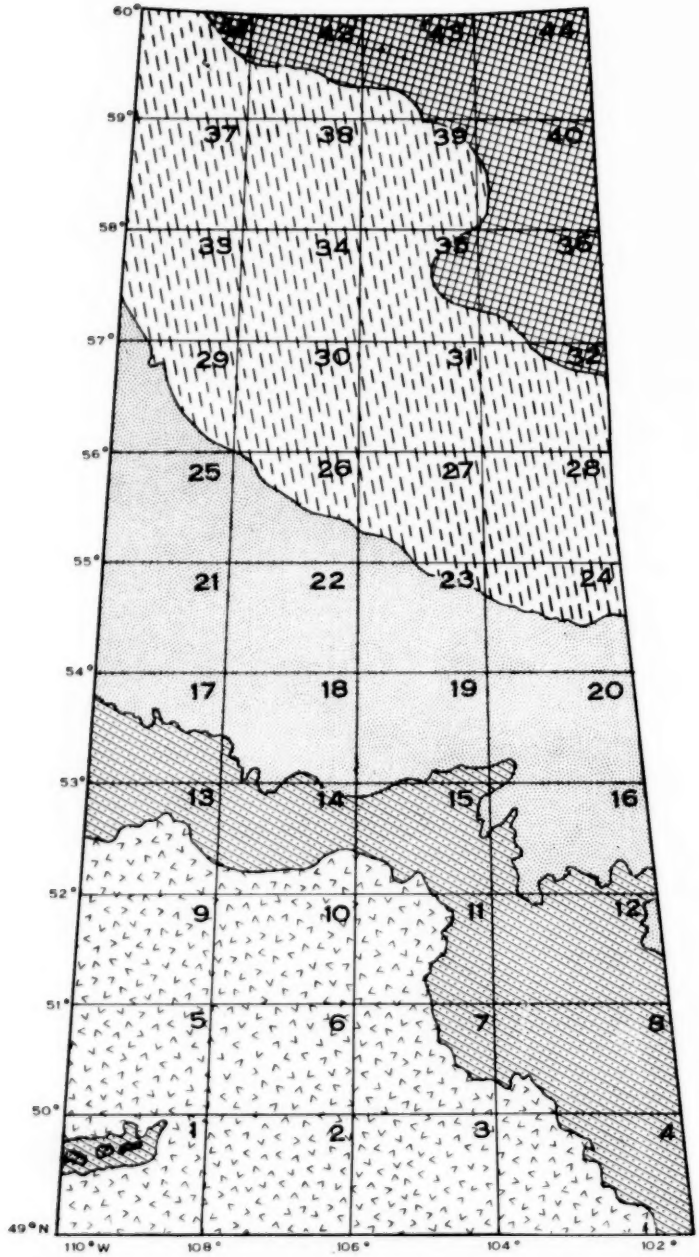

FIG. 1. Map of Saskatchewan showing zones of natural vegetation outlined in the text. The province is divided into numbered squares for the purpose of locating collections cited in the list of species. Regina is in block 7, Saskatoon in 14, Prince Albert in 19.

The whole Province was recently glaciated, leaving bare, eroded Pre-Cambrian and early Paleozoic rocks in the north and great accumulations of drift (as much as 400 feet) in the south, covering Cretaceous and Tertiary beds.

Mean annual temperatures range from 15° F to 40° F, with January means at —30° to 12° F and July means at 58 to 68° F. Extremes of 110° occur in the southwest, and —60° F is "not rare" in the north. Permafrost is known north of 59° N. Precipitation, ranging from 10 to 18 inches (±4), occurs mostly in June, July and August. In most of the Province evaporation from a free water surface exceeds rainfall. The southern limit of mixed forest coincides closely with the line where precipitation and evaporation are equal.

Natural vegetation, as shown on the map (*fig.* 1), falls, from south to north, into the following categories:

1. Mixed prairie (grassland).
2. Parkland prairie (aspen grove).
   a. Tallgrass prairie with aspen-oak bluffs.
   b. Fescue grasslands with aspen bluffs.
   c. Transition between true prairie, mixed prairie and fescue grasslands with aspen bluffs.
   d. Cypress Hills fescue grasslands.
3. Mixedwood forest
   a. Normal transcontinental Mixedwood.
   b. Cypress Hills forest.
4. Northern coniferous forest.
5. Forest-tundra transition. Northern transition.

Mosses first become prominent in the forest zone. The Mixedwood is chiefly aspen, black poplar, paper birch, white and black spruce, balsam fir, jack pine and tamarack, on gray podsolic soils. The Northern coniferous forest has the same components, with decided dominance of the evergreens.

Mr. Welsh adds: The vegetation of the Mixedwood is very varied; that of the Coniferous forest is fairly uniform. Sphagnum bogs cover thousands of acres, with *S. capillaceum* seeming to predominate. *Marchantia polymorpha* is common in these bogs. Moss covers approximately 80% of the forest floor. *Hylocomium splendens* is everywhere, even on poor jack pine (*Pinus banksiana*) soils. *Calliergonella schreberi* is common, especially on the richer soils. *Dicranum rugosum* may be found anywhere, but especially on poorer soils. Polytrichums are abundant and conspicuous. In Coniferous forest and in Mixedwood *Ceratodon purpureus* occurs wherever mineral soil has been exposed. And most of the poplars

(*P. tremuloides* and *P. tacamahacca*) wear a stocking of *Pylaisia polyantha*.

MUSCI[2]

Amblystegium juratzkanum 14, 15, 19
serpens 8, 10, 14, 18, 19, 25, 27
varium 21
Andreaea rothii v. *crassinervia* 41
rupestris 43
Aulacomnium palustre 10, 17, 19, 23-28, 41
turgidum 27, 41
Barbula acuta 8
convoluta 18, 23, 27
unguiculata 18, 21
Bartramia pomiformis 27
Brachythecium albicans 18, 22
flagellare 16
flexicaule 25
glareosum 1
rivulare 19
salebrosum 4, 10, 14, 16, 18, 19, 26, 27
Bryum argenteum 14, 19, 21
caespiticium 7, 14, 17, 18, 19, 22, 23, 27
capillare 9, 17, 43
cuspidatum 7, 8, 14, 15, 18, 19, 23, 27, 28, 41
inclinatum 41
pendulum 8, 14, 18, 19
pseudotriquetrum 10, 18, 19, 23
turbinatum 17, 19, 28, 36
uliginosum 19
Calliergonella schreberi 1, 17, 18, 19, 23, 25, 27, 41
Camptothecium nitens 18, 19, 39, 41, 43
Campylium chrysophyllum 19, 23
hispidulum 27, 41
stellatum 23, 26
Ceratodon purpureus 7-9, 14, 16-19, 21-24, 27, 28, 41, 43
Chamberlainia acuminata 19
Climacium dendroides 23, 24, 41
Dicranella heteromalla 18
varia 16
Dicranum bergeri 26, 27, 41
bonjeanii 9, 27
flagellare 18
fragilifolium 26, 27
fuscescens 21, 27
rugosum 17-19, 21, 27, 30, 36, 43
scoparium 43
Didymodon recurvirostris 10, 19, 26
Distichium capillaceum 14, 27, 41
Ditrichum ambiguum 24
pusillum 22
Drepanocladus aduncus 14
v. *kneiffii* 8, 16
v. *polycarpus* 8, 16, 19
f. *gracilescens* 8, 23
uncinatus 1, 17, 18, 27, 41
Encalypta rhabdocarpa v. *subspathulata* 41
Ephemerum serratum (Bryol. *60*: 51) 20
Eurhynchium pulchellum 18, 19, 27
substrigosum 10, 18, 27
Fontinalis dalecarlica[3]
macounii[3] 41
duriaei[3]
hypnoides[3]
Funaria hygrometrica 8, 14, 17, 19-24, 27, 41, 44
Grimmia affinis 43
apocarpa v. *conferta* 43
Hedwigia ciliata 26, 27
Helodium blandowii 19

[2] Citation of authorities for the names has been omitted. These, and descriptions of the species, will be found in Grout's *Moss Flora of North America*, Andrews' "Sphagnaceae" in *North American Flora* and Frye & Clark's *Hepaticae of North America*.

[3] *fide* Winona H. Welch in *lit.*

Hylocomium splendens 17, 19, 23, 27, 39, 43
Hypnum cupressiforme 26
crista-castrensis 1, 17, 18, 27
hamulosum 41
lindbergii (*patientiae*) 26, 41
reptile 18, 27
vaucheri 16, 20
Leptobryum pyriforme 6, 10, 14, 19, 20, 24, 27, 41, 43
Leptodictyum riparium 8, 16, 20
trichopodium 6
v. *kochii* 6, 16, 19
Leskea nervosa 22
v. *nigrescens* 21, 24
Mnium affine 10, 16, 19-21, 25
v. *rugicum* 19
cuspidatum 14, 17, 18, 19, 22, 24, 26, 27
drummondii 27
punctatum 41
serratum 27
spinulosum 18, 19
Myurella julacea 19
Neckera pennata v. *oligocarpa* 27, 42
Oncophorus polycarpus 27
v. *strumiferus* 27, 43
virens 43
wahlenbergii 18
Orthotrichum anomalum v. *saxatile* 18
elegans 22
macounii 41
v. *lonchothecium* 26
obtusifolium 22
strangulatum 24
Paraleucobryum longifolium 27
Plagiopus oederi 9, 41
Plagiothecium pulchellum 27
turfaceum 27
Pohlia cruda 41
gracilis 16, 27
nutans 18, 19, 21, 23, 25, 27, 28, 36, 41, 43
v. *triciliata* 19
wahlenbergii 10
Polytrichum commune 23
juniperinum 2, 17-19, 23, 24, 26-28, 41, 43
piliferum 19, 41, 43
Pottia bryoides (Carlton House, *Drummond*)
heimii 14, 15
Pylaisia jamesii 8, 14, 18, 20, 26
polyantha 4, 14, 15, 18-23, 26, 27, 41
v. *pseudoplatygyria* 14, 18, 19, 21, 24-27, 41
subdenticulata 18
Scorpidium scorpioides 19
Sphagnum capillaceum 17, 22, 26, 27, 41
girgensohnii 28
magellanicum 27
robustum 23, 27
squarrosum 27, 43
teres 41
warnstorfianum (*warnstorfii*) 28, 41
Tetraphis pellucida 27
Tetraplodon mnioides 23, 27, 43
Thuidium abietinum 27, 41
recognitum 25, 27
virginianum 16, 18, 19
Tortula mucronifolia 2, 7, 10, 11, 14, 18, 19
ruralis 1
Ulota curvifolia 41

HEPATICAE

Barbilophozia barbata 27
Jamesoniella autumnalis 18
Lepidozia reptans 27
Lophozia ventricosa 27
Marchantia polymorpha 14, 16, 19-23, 27, 36, 41, 43
Marsupella emarginata 41
Mylia anomala 27, 41
Ptilidium ciliare 19, 23, 26, 27, 41, 43
pulcherrimum 27

THE IDENTITY OF PARMELIA HYPOTROPOIDES

MASON E. HALE, JR.[1, 2]

In the past several years the writer has collected *Parmelia erecta* Berry very frequently throughout the southern states, where it is one of the commonest lichens, a typical canopy species growing in the tops of oak trees. During a recent study of type specimens in the Willey Herbarium at the U. S. National Museum, it was found that *P. erecta* is actually identical with *P. hypotropoides* Nyl. *ex* Willey, described in 1896 from New Bedford, Massachusetts. This paper is intended to clarify the nomenclature, distribution and chemistry of this common but unrecognized lichen.

NOMENCLATURE

PARMELIA HYPOTROPOIDES Nyl. *ex* Willey, Bot. Gaz. 21: 204. 1896. Type specimen in the U. S. National Museum, from New Bedford, Mass., on trees. *H. Willey,* in 1895. *Parmelia erecta* Berry, Ann. Mo. Bot. Garden 28: 103. 1941. Type specimen in Missouri Botanical Garden, No. 154724, near Marble Falls, Newton Co., Arkansas, *Dodge, Berry & Johnson.*

EXSICCATAE EXAMINED: Cummings, *Decades N. A. Lichens* 100 (US), sub. nom. *Parmelia perforata;* Lojka, *Lich. Univ.* 110 (US), sub nom. *Parmelia perforata* var. *hypotropa;* Hale, *Lich. Amer. Exs.* 5 (US), sub nom. *Parmelia erecta.*

Fink in his *Lichen Flora of the United States* listed the species as *Parmelia hypotropodes* [sic] with the entirely different *P. cetrata* var. *hypotropodes* [sic] as a synonym. It is not mentioned in Berry's monograph at all.

A description of the species based on recent herbarium material is given below:

Thallus (FIG. 1) foliose, expanded, 5-20 cm. in diameter, the lobes rounded and broad, 1-5 cm. wide, 2-5 cm. long, the margins ascending, often crenulate, with numerous cilia 1-4 mm. long, the lobes sometimes extending into narrow laciniae 1-3 mm. wide and 5-10 mm. long; isidia and soredia absent; upper surface light mineral-gray (when dry), sometimes turning buff-pink in the herbarium; undersurface smooth toward the margins, white to rarely avellaneous, the central portion black with rhizines, sharply

[1] Most of the specimens cited in this article were collected during field work supported by Sigma Xi-RESA and the American Philosophical Society.
[2] Smithsonian Institution, Washington 25, D. C.

FIG. 1. Specimen of *Parmelia hypotropoides* Nyl. Natural size.

delimited from the submarginal white area. Apothecia abundant, 2-15 mm. in diameter, the older ones perforate.

This conspicuous lichen most closely resembles *Parmelia perforata* (Jacq.) Ach., which, however, has a uniformly darker underside, fewer marginal cilia and more linear, branched lobes. Both species are classified in the Section Amphigymnia.

DISTRIBUTION

Parmelia hypotropoides has been collected most frequently in the southern states (FIG. 2.). It has a definite northern limit of distribution in the Ohio River Valley and the central Appalachians, but it goes as far north as Massachusetts along the Atlantic Coast. Specimens cited below with number only are collected by the writer and preserved in the U. S. National Herbarium, unless otherwise indicated.

MASSACHUSETTS: New Bedford, Bristol Co. *H. Willey* in 1895 and in Lojka, *Lich. Univ.* 110; Woods Hole, Barnstable Co., *R. A. Harper* 193 (WVA). CONNECTICUT: Central Village and Moosup, Windham Co. *Sheldon* in 1900 (WVA). NEW JERSEY: Vineland, Cumberland Co. *H. A. Walker* in Cummings, *Decades N. A. Lich.* 100. VIRGINIA: 2 mi. E. of Hillsville (12638); 10 mi. E. of Fancy Gap, Carroll Co. (12882, 12889); 2 mi. NW. of Floyd, Floyd Co. (12826). NORTH CAROLINA: Near Taylorsville, Alexander Co. (8104); near Durham, Durham Co. (10456); Gastonia, Gaston Co. (8135). SOUTH CAROLINA: Chester, Chester Co., *H. A. Green* in 1883; Windsor, Aiken Co. (7598); Ehrhardt, Bamberg Co. (7632); Blackwell, Barnwell Co. (7650); 1 mi. SE. of Beaufort, Beaufort Co. (7619); King Mountain State Park, Cherokee Co. (7718); 2 mi. N. of Greenville, Greenville Co. (7769); Dyson, Greenwood Co. (7668). GEORGIA: Trenton, Dade Co. (7372); 6 mi. NW. of Blue Ridge, Fannin Co. (14258); Rutledge, Morgan Co. (7488); near Chatsworth, Murray Co. (7438);

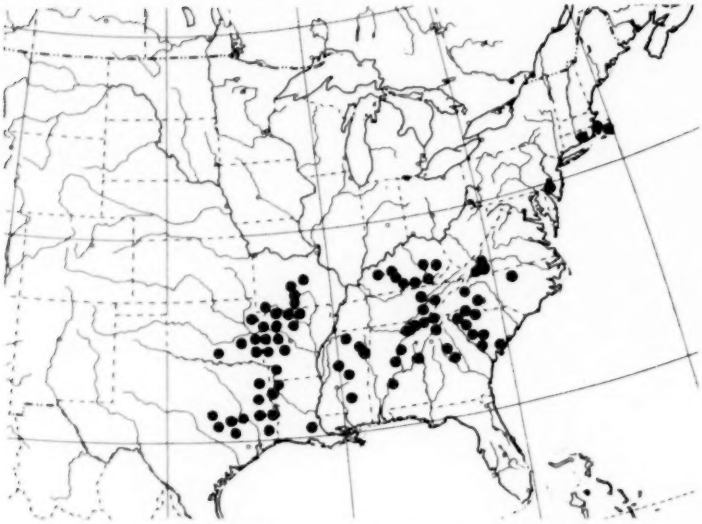

FIG. 2. Distribution of *Parmelia hypotropoides* Nyl.

Eatonton, Putnam Co. (7520); Vogel State Park, Union Co. (7329); near Cleveland, White Co. (7453). ALABAMA: Cheaha Park, Cleburne Co. (7075); Valley Creek Park, Dallas Co. (7185); DeSoto Park, Dekalb Co. (7018); Pell City, St. Clair Co. (7236); Oak Mountain Park, Shelby Co. (7131); Epes, Sumter Co., *F. T. McFarland* 633. MISSISSIPPI: Collins, Covington Co. (7976); Durant, Holmes Co. (7876); 2 mi. E. of Tupelo, Lee Co. (7812); ½ mi. S. of Columbus (14255); 1 mi. S. of Holly Springs, Marshall Co. (7851); Longview, Oktibbeha Co. (7942); Morton, Scott Co. (7908). LOUISIANA: Benton, Bossier Parish (5632); 1 mi. N. of Shreveport, Caddo Parish (5611); Breux Bridge, St. Martin Co., *A. Langlois*. TENNESSEE: Cades Cove, Blount Co., *Cain* in 1938 (TENN); Cumberland, Cumberland Co., *Mozingo* in 1950 (TENN); Heiskell, Knox Co., *Cain* 113 (TENN); Tellico Plains, Monroe Co., *Mozingo* in 1950 (TENN). KENTUCKY: 2 mi. W. of Cave City, Barren Co. (13199); 8 mi. NW. of Brownsville (13862) and Mammouth Cave (13150), Edmonson Co.; Annville, Jackson Co. (13674); 4 mi. E. of Whitley City (13754) and 10 mi. E. of Whitley City (13785), McCreary Co.; 1 mi. SW. of Brewer, Owsley Co. (13468); 6 mi. SE. of Oil Valley, Wayne Co. (13821); 5 mi. SW. of Corbin, Whitley Co. (13472). MISSOURI: Cassville, Barry Co. (2608); near Ava, Douglas Co. (4305); Almartha, Ozark Co. (4340); near Kirbyville, Taney Co. (4389); near Houston, Texas Co. (4235). ARKANSAS: Three Brothers, Baxter Co. (4437); Berryville, Carroll Co. (2763); 5 mi. E. of Cass, Franklin Co. (4062); Crystal Springs, Garland Co. (3051); 2 mi. N. of Ozone, Johnson Co. (3850); Bradley, Lafayette

Co. (5596); Combs, Madison Co. (3463); Buffalo River State Park, Marion Co. (4482); Albert Pike Recreation Area (3910) and Mt. Ida (3015), Montgomery Co.; Ponca, Newton Co. (2800); 8 mi. S. of Hollis, Perry Co. (3015); 8 mi. SW. of "Y City" (3563, 3955) and 5 mi. W. of Nola (3617), Scott Co.; Tomahawk, Searcy Co. (3285); near Winslow, Washington Co. (2659); Danville, Yell Co. (3735). OKLAHOMA: Ardmore, Carter Co. (4851); Ludlow, LeFlore Co. (5050); Beaver Bend State Park, McCurtain Co. (4905); S. of Albion, Pushmataha Co. (4968); N. of Sallisaw, Sequoyah Co. (5019). TEXAS: Rogers, Bell Co. (5313); southern Bexar Co., *C. D. Orchard* 5; 1 mi. N. of College Station, Brazos Co. (5375); Daingerfield, Cass Co. (5402); Rusk, Cherokee Co. (5297); Mother Neff State Park, Coryell Co. (5512); Gillespie Co., *Jermy* 423; Jasper, Jasper Co. (5413, 5417); Jefferson, Marion Co. (5282); Milano, Milam Co. (5470); Sutton, Robertson Co. (5520); Pointblank, San Jacinto Co. (5554).

CHEMISTRY

The chemical characters of *Parmelia hypotropoides* are distinctive. Norstictic acid (K+ red) in high concentration and atranorine were demonstrated in all but two specimens with Asahina's microchemical techniques (G. A. o-T). Two specimens from Texas containing stictic acid (K+ yellow) instead of norstictic (5313, 5375) represent a rare chemical strain. *P. perforata* contains salacinic acid and atranorine so that the two species may be separated easily with a chemical test.

SUMMARY

Parmelia erecta Berry is synonymous with *P. hypotropoides* Nyl. *ex* Willey. This common corticolous lichen is found in the canopy of oak trees throughout the southern states. The color of the underside and other minor morphological traits as well as the presence of norstictic (rarely stictic) acid differentiates the species from *Parmelia perforata.*

A NEW RECORD FOR CYPHELIOPSIS BOLANDERI

ALBERT W. C. T. HERRE[1]

The outstanding lichen, *Cypheliopsis bolanderi* (Tuck.) Vainio, was described in 1866 by Tuckerman under the name of *Acolium bolanderi.* His specimens were collected in and near San Francisco, on sandstone and other rocks. Later, it was found along the coast of southern California by Dr. H. E. Hasse. Still later, I found it was common on maritime rocks and in the coast range

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all along the California coast. Several years ago, it was discovered on the coast of Oregon near Coos Bay.

Recently, the veteran collector, W. J. Eyerdam, made a trip to Victoria, Vancouver Island, British Columbia. While there, he collected lichens from rocks on the seashore. Among them, I was surprised to find a fine series of *Cypheliopsis bolanderi*. This is a notable and unexpected addition to the lichen flora of British Columbia. The known range of this lichen now extends along the Pacific coast from Vancouver Island to Baja California, including the offshore islands of California.

PURE CULTURE OF FRULLANIA[1]

GRACE BLANCHARD IVERSON[2]

In the course of studies of phylogenetic relationships among species of the leafy liverwort genus *Frullania*, pure cultures of 17 species were established from spores, for morphological comparison. Most of these species have exhibited normal morphology and a reasonably rapid growth rate in favorable media. As plants grown under uniform conditions employing simple facilities and techniques are useful for a variety of studies, a description is given of the methods used for culturing *Frullania* and of the growth of plants in different media.

MATERIALS AND METHODS

CULTURE TUBES. The cultures were grown in cotton-stoppered Pyrex test tubes 1.5 × 15 cm. holding about 12 cc. of medium. Culture glassware was cleaned in sulphuric acid-potassium dichromate solution and washed in running tap water followed by three rinses in distilled water and two in Pyrex glass double-distilled water. Test tubes have an advantage over larger containers in allowing observation through the tube with a dissecting microscope at magnifications up to 30 diameters during growth and when transferring individual plants.

[1] These studies were aided in part by a predoctoral fellowship (1955-56) from the National Science Foundation. The author wishes to express gratitude to the bryologists who have supplied many of the collections of living plants used in this study, M. FULFORD, H. A. MILLER, P. M. PATTERSON, W. B. SCHOFIELD, R. M. SCHUSTER, A. J. SHARP, R. D. SVIHLA and K. A. WAGNER, and to W. C. STEERE and M. FULFORD for aid in the preparation of the manuscript.

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MEDIA. A medium was sought which would allow rapid and normal growth, and, if possible, production of sporophytes. A basic medium was selected and slightly modified from media found satisfactory for other liverworts; the major salts are those of Benecke's solution (Müller, 1939), also used by Prát (Diller, Fulford & Kersten, 1955a), the ferric chloride being replaced in the present study by four trace minerals (modification of Voth & Hamner, 1940).[3] All media contained 1% sucrose (Diller, Fulford & Kersten, 1955b). Media were made up with Pyrex glass double-distilled water. For some of the current experiments three additional substances found beneficial by other investigators for growth of lower plants were used: yeast extract (Diller, Fulford & Kersten, 1955a), tryptone (Schuler, Diller, Fulford & Kersten, 1955) and naphthyleneacetic acid (NAA) (von Witsch, 1940; Fries, 1943; Wetmore & Morel, 1949). Only one concentration of each was tried. Some culturing was done on media containing Difco agar in concentrations of 1% and 0.3%.

Acidity determinations with a Beckman pH meter showed that the media were around pH 5.4 when the plants were introduced. The pH decreased to around 4.3 after plants had grown in the media for several weeks. The natural substrate for most of the *Frullania* species used in the present study is acid; for example pH 5-6.8 was found for the tree bark on which *Frullania eboracensis* was growing (Robinove & LaRue, 1929), and around pH 4.8 for the substrates of *F. asagrayana* (Schuster, 1953).

LIGHT AND TEMPERATURE. Culture tubes in slanted position were lighted by a combination of three 40-watt fluorescent lamps, warm white, daylight and cool white. In one culture room, with an 18-hour day, these supplied from 11 to 180 foot candles at the levels of the cultures. In the other room, with a 12-hour day, the lamps gave 50 foot candles at the cultures. Temperatures varied with season and time of day, being 18-28°C during the light period, with a drop to 14-24°C during the dark period. Most experiments

[3] BASIC MEDIUM: per liter of solution.

Major salts		Trace minerals	
0.2 g.	NH_4NO_3	0.0002 g.	$MnSO_4$
0.1	KH_2PO_4	0.0002	$ZnCl_2$
0.1	$MgSO_4 \cdot 7H_2O$	0.0002	$Na_2B_4O_7$
0.1	$CaCl_2 \cdot 2H_2O$	0.00002	Ferric citrate

Ferric citrate replaces $FeSO_4$ of Voth & Hamner (1940). During later experiments 0.1 g. KH_2PO_4 was replaced by 0.19 g. KH_2PO_4 plus 0.02 g. K_2HPO_4. All media contained 1% sucrose. Media were autoclaved for 12 minutes at 18 lbs. and 112°C.

did not test the difference in growth of comparable plants under different conditions of light and temperature, but when this was done, the only difference noted was in the germination rate. This was faster for some species in the warmer location with the 12-hour day and for others in the cooler location with the 18-hour day. Apparently these species have a wide range of temperature and light tolerance when grown under the conditions provided.

ORGANISMS. *Frullania* is a large genus of leafy liverworts composed mostly of tropical species. Probably 22 species occur in North America north of Mexico. Most of these are found on the bark of living trees and are among the more xerophytic of the Hepaticae. All collections from which spores were grown are North American with the exception of that of *F. meyeniana*, which is from the Hawaiian Islands. The species of *Frullania* which have been cultured are arranged by subgenus in TABLE I. Individual plants providing spores for a culture were mounted in Hoyer's solution (Anderson, 1954) as permanent reference slides. Sometimes enough anilin blue (Johansen, 1940) was added to the Hoyer's solution to tint the medium blue; this gradually gives a light blue stain to the new growth, which would otherwise become nearly transparent.

PROCEDURE. Spores from mature, unopened sporangia of living plants were used to start the cultures. Sporelings were obtained from 63% of these sporangia; some failures resulted from use of sporangia which were old or imperfectly formed. Of the tubes inoculated with spores, 93% were free from contamination when the sporangia were treated as follows. A sporangium picked with forceps was handled with a platinum loop which had been dipped in alcohol, flamed and cooled. Each sporangium was decontaminated in a test tube containing about 5 cc. of 5% Chlorox solution in distilled water. Best results were obtained when sporangia were treated for 5 minutes in Chlorox solution followed by washing in four changes of sterile distilled water, about 10 cc. and 5 minutes per wash, each solution being poured off leaving the sporangium in the tube.

Planting and transfer procedures were as follows. In a drop of water remaining after the last wash a sporangium was broken with a sterile glass rod to produce a suspension of spores. Inoculation of germination tubes and subsequent transfers can be done by moving the spores or plants with a loop, or by decanting the solution from around the plants, when transferring, and filling the tube from a flask of medium. The latter method proved quicker, and when carried out in a small closed room, repeated transfers

TABLE I. Growth of *Frullania* species in two of the Experimental Media. Morphology of plants and rate of growth are considered in the ratings: good ++, fair +, and poor —. (*F. oakesiana* was observed for the last time in germinating stages in mineral-sucrose and mineral-sucrose-NAA media.)

	Germination & growth to adult form		Growth of adult plants	
	mineral-sucrose	mineral-sucrose-NAA	mineral-sucrose	mineral-sucrose-NAA
Subg. TRACHYCOLEA				
F. squarrosa (Reinw., Blume & Nees) Dum.	—	—	+	+
F. brittoniae Evans			++	—
F. eboracensis Gottsche		—	++	+
F. bolanderi Aust.	++	+	++	+
F. inflata Gottsche	++	+	++	+
F. catalinae Evans	—		—	—
F. oakesiana Aust.				
Subg. GALEILOBA				
F. cobrensis Gottsche	++	++	++	++
Subgenus DIASTROLOBA				
F. donnellii Aust.			++	++
F. kunzei Lehm. & Lindenb.	++	++		++
F. obcordata Lehm. & Lindenb.	++	++	++	+
F. meyeniana Lindenb.	++	++	++	+
Subg. CHONANTHELIA				
F. riojaneirensis (Raddi) Spruce	++	++	++	++
Subg. THIOPSIELLA				
F. nisquallensis Sull.	++	+	+	+
F. franciscana Howe	++	++		—
F. californica (Aust.) Evans	—		+	—
F. asagrayana Mont.	++	+	++	+
	++ 10	++ 6	++ 10	++ 4
	+ 0	+ 4	+ 3	+ 8
	— 3	— 2	— 1	— 4

resulted in contamination of less than 0.5% of the tubes. When about 100-150 spores are germinated in 12 cc. of solution, a month after inoculation may be early enough for the first transfer. With 4-6 adult plants per tube, transfer every two or three weeks appears to maintain the plants in active growth.

GERMINATION AND VEGETATIVE GROWTH IN DIFFERENT MEDIA

Germination in culture begins with cell divisions producing a spherical protonema, which when 2-6 weeks old sends out one to several rhizoids. At 4-10 weeks of age, the sporeling develops a shoot with primary and juvenile leaves; 8-14 weeks after planting, leaves of adult form are produced and the shoot begins to branch.

The evaluation of growth in different media is based on morphology of the plants and growth rate.

Mineral-Sucrose Medium. In a mineral –1% sucrose medium, germination rate and morphological stages up to the adult form were good in 10 of the 13 species germinated. Later growth on this medium was good in 10 of the 14 species of adult plants for which it was used. Table I shows these data. The exceptions, where growth was poor, were *F. squarrosa,* which grew abnormally, especially in the early stages, and *F. catalinae* and *F. californica,* which had not reached a normal rate and form of growth after 8 and 9 months, respectively. None of these species benefited by the addition of 25 gammas per liter of the auxin NAA. Sugar may be the unfavorable factor for growth of these species, as is reported for some other liverworts (Allsopp, 1957). It is interesting that species closely related to the latter two species, *F. inflata* (which sometimes includes the species *F. catalinae* as a variation) and *F. franciscana, F. nisquallensis* and *F. asagrayana* (in the same subgenus with *F. californica*) made good growth in the mineral-sucrose medium. There appear to be physiological differences between these closely related species.

Addition of Yeast Extract. The germination of two species, *F. asagrayana* and *F. franciscana,* which had normal development in mineral-sucrose medium, was adversely affected by the addition of 0.2% yeast extract to the mineral-sucrose medium. In both species there was a strong tendency for the protonema to grow into a large knobby ball of 5 mm. or more in diameter, sometimes possessing rhizoids but rarely producing a leafy shoot.

Addition of Tryptone. Tryptone was added to the mineral-sucrose medium in a concentration of 0.04% for the germination medium of two species, *F. bolanderi* and *F. franciscana,* which had normal development in mineral-sucrose medium. This benefited germination and early growth, the sporelings growing faster and to a larger size than in mineral-sucrose medium. There is, however, a tendency for production of more rhizoids and some crowding of the leaves on the stem.

Addition of Tryptone and Naphthyleneacetic Acid (NAA). Tryptone in a concentration of 0.04% and 25 gammas per liter of the auxin NAA were added to the mineral-sucrose medium for germination of six species, *F. bolanderi, F. cobrensis, F. donnellii, F. kunzei, F. obcordata* and *F. franciscana.* All except *F. donnellii* were started also in mineral-sucrose medium, where they grew normally. Growth in a mineral-sucrose-tryptone-

NAA medium was not considered better than in mineral-sucrose alone or in mineral-sucrose-tryptone. Rate of growth and size attained by the sporelings was similar to that in mineral-sucrose-tryptone medium, but form was less normal than in this medium or mineral-sucrose medium. There was a greater tendency for the leaves to be crowded, rhizoids more numerous and frequency of regeneration increased.

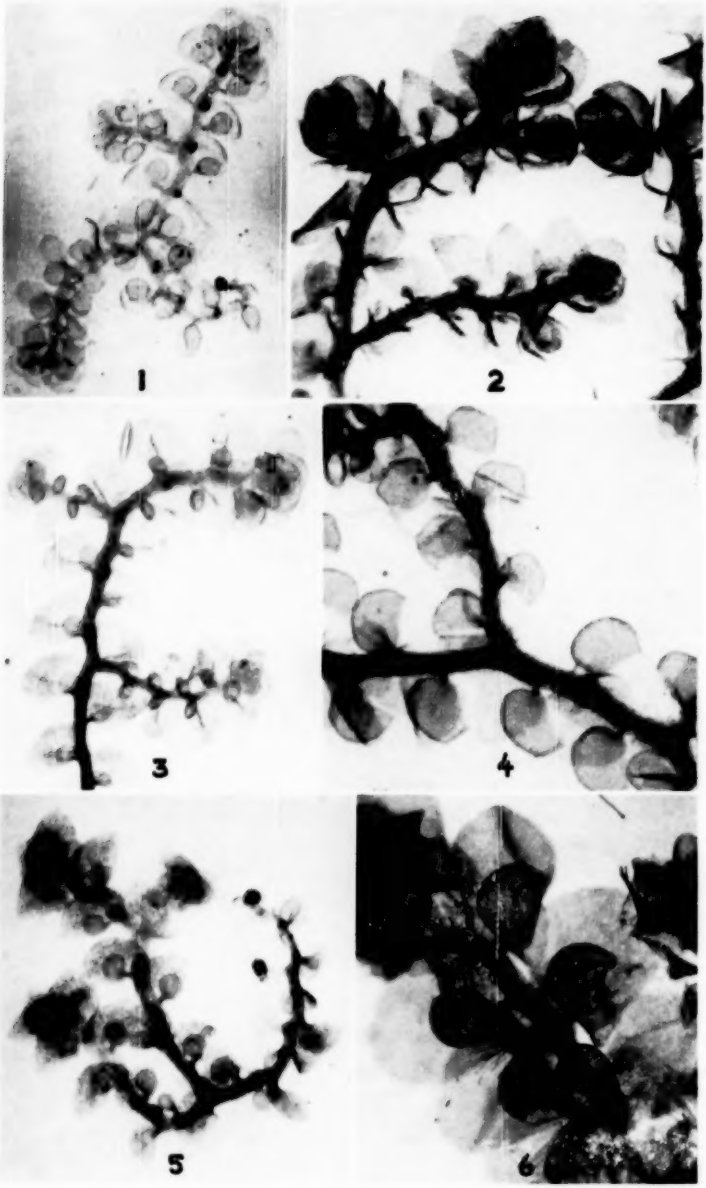
Addition of Naphthyleneacetic Acid (NAA). The effect of the addition of 25 gammas per liter of the auxin NAA to mineral-sucrose medium was observed on germinating spores of 12 species and adult plants of 16 species (*table* I). As sporelings, more than half of the species tried grew considerably faster in medium containing NAA.[4] Morphology was fairly normal, though often more rhizoids were produced by the protonema and young leaves, and the protonema somtimes grew larger than normal. After the plants had two or three leaves, for several species NAA was not considered beneficial. Though growth rate sometimes remained higher than in mineral-sucrose medium, in many cases there was an increasingly harmful effect upon the form of the plants similar to that when tryptone and NAA were used in medium for germination.

Agar. The addition of 0.3% of agar, just barely thickening the mineral-sucrose medium, was tried for one species, *F. asagrayana;* it allowed more rapid germination and growth of the sporelings than did the mineral-sucrose medium. When a mineral-sucrose-NAA medium was similarly thickened for *F. franciscana,* growth was normal. Solidification of two of the media with 1% agar was not beneficial. When mineral-sucrose-NAA medium was solidified for *F. franciscana* and *F. nisquallensis,* they grew as in solution or less normally than they did in solution. Solidification of the mineral-sucrose-yeast extract medium with agar for *F. franciscana* and *F. asagrayana* did not markedly change the abnormal growth form obtained in the same medium as a liquid.

Formation of Reproductive Structures

Two species of *Frullania* have produced apparently normal reproductive structures. *Frullania inflata* grown in mineral-sucrose solution has produced many antheridial branches with

[4] In connection with these effects of NAA, an auxin extraction and *Avena* assay were made from gametophytes of four liverworts, *Pallavicinia lyellii* (Lindenb.) Gray, *Porella* sp. (from San Mateo Co., Calif.), *Frullania franciscana* Howe, and *F. squarrosa* (Reinw., Blume & Nees) Dumort. A growth promoting substance(s) was detected in all four species. The auxin determination was carried out by Dr. W. R. Briggs of Stanford University.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spherical antheridia discernible through the bracts and somewhat fewer young perianths with enclosed archegonia (*fig. 2*). Similar plants in the mineral-sucrose-NAA medium did not become reproductive until several weeks later. In one culture of *F. donnellii*, a few antheridial branches were formed in mineral-sucrose solution or after transfer to mineral-sucrose-NAA medium.

Regeneration

When transfers are not frequent enough, particularly when plants are grown in medium containing NAA or tryptone, death of the original plants, commencing at the growing points, may be accompanied by regeneration. Callus-like masses of cells and sometimes new shoots are produced by the protonema, stem, leaves and shoot apex. Regeneration on the stem usually occurs just below the attachment of the lobule of the leaf. Similar regeneration has sometimes been observed in the wild *Frullania* plants maintained in the laboratory. Under natural conditions, it is reported that regeneration from most cells of the *Frullania* plant is possible and occurs not uncommonly (Lorenz, 1912; Fulford, 1954).

Morphological Comparison of Cultured Plants with Plants from Natural Habitats

Sample plants have been photographed to show the normal form attained by *Frullania* species grown from spores in favorable liquid medium free from other organisms (*fig.* 1-8). Generally only the larger details of form can be determined from the photographs, but these aspects of the cultured plants may be compared with descriptions and illustrations of the species (Evans, 1897, 1900; Frye & Clark, 1937-47; Schuster, 1949, 1953). The vegetative characteristics of the genus develop normally. In the photographs, the two dorsal rows of leaves may be seen projecting laterally along the stem, and the single ventral row of *underleaves* is visible in

Fig. 1-6. *Frullania* plants grown in pure culture in liquid media, photographed mounted in Hoyer's solution—× 20. 1. *F. franciscana* (613, Calif.), grown from a spore in mineral-sucrose-NAA medium with 0.3% agar for 101 days; ventral view. 2. *F. inflata* (610, Tenn.), grown from a spore for 222 days in mineral-sucrose solution; dorsal view showing antheridial and archegonial branches. 3. *F. asagrayana* (6317, *Schofield*, Nova Scotia, Canada), grown in mineral-sucrose solution; dorsal view showing ocelli forming a median line on the dorsal lobe. 4. *F. bolanderi* (623, Calif.), grown in mineral-sucrose-tryptone solution; ventral view. 5. *F. nisquallensis* (691, Ore.), grown from a spore in mineral-sucrose solution for 109 days; dorsal view. 6. *F. riojaneirensis* (36801, *Schuster*, Fla.), grown in mineral-sucrose-NAA solution; ventral view.

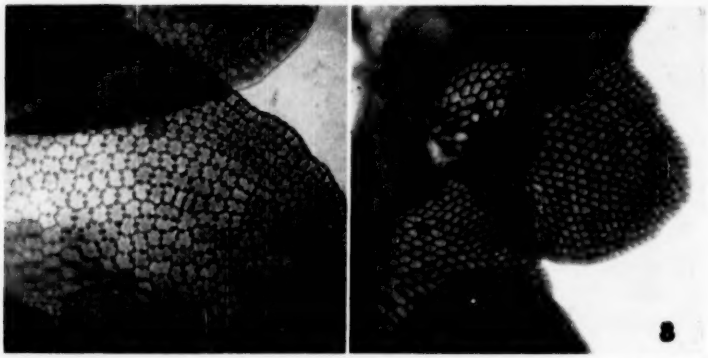

FIG. 7-8. *Frullania* plants grown in pure culture in liquid media and photographed mounted in Hoyer's solution— × 84. 7. Same plant as in fig. 6; dorsal view showing cell walls with trigones and intermediate thickenings. 8. *F. meyeniana* (720, Oahu, T. H.), grown in mineral-sucrose-NAA solution; dorsal view showing cell walls lacking trigones and intermediate thickenings.

figure 6, with a tuft of rhizoids growing from the ventral surface of each underleaf. A dorsal leaf has three parts: a flat or arched *dorsal lobe,* a smaller and usually sac-shaped ventral *lobule,* and between the lobule and the stem a small plate or filament, the *stylus* (not visible in the photographs). The shape, orientation, dimensions and attachment to the stem of these parts are specific characteristics.

In the cultured plants the dorsal lobe of the leaf is similar in morphology to that of wild plants of the same species. Occasionally it is squarrose when not normally so. With the exception of one species, the lobule of the leaf forms a sac. In *F. inflata* the lobule remains explanate in culture (*fig.* 2) as it commonly does in wild plants. The regular formation of sacs by most of the species when grown under water is interesting in view of the frequent observation that explanate lobes form on plants growing in wet or submerged conditions (Goebel, 1905; McGregor, 1955) or in sheltered habitats (Evans, 1897). The stylus and underleaf of the cultured plants are typical of the species. The shape of both dorsal and ventral leaves at the junction with the stem is normal. Cell modifications characteristic of the species also develop in culture. In the dorsal lobe of *F. asagrayana, F. franciscana* and *F. nisquallensis, ocelli* are formed, making a line visible in figure 3 and on some leaves in figure 5. Enlarged cells are developed at the

base of the dorsal lobe in *F. cobrensis*. The *trigones* at cell wall intersections and the *intermediate thickenings* along the wall between two cells (*fig.* 7 and 8) are comparable with those of wild plants. Cell walls are, however, often thinner and trigones and intermediate thickenings are sometimes present in young plants of species which lack them in the adult. In sporelings, the normal non-folded *primary leaf* and the folded and inflated *juvenile leaf* forms (summarized by Fulford, 1954) are produced on the young stem emerging from the globose *protonema* (*fig.* 1, 5). Limited results indicate that antheridial and archegonial branches are also of normal morphology (*fig.* 2).

Summary

Plants of 17 species of *Frullania*, representing five subgenera, have been established in pure culture in test tubes. Growth of most species is good in mineral-sucrose solution. Preliminary experiments with the addition of other components to the medium suggest that for culture of *Frullania* neither 0.2% yeast extract nor solidification of the medium with agar is beneficial. Addition of 0.04% tryptone or 25 gammas per liter of NAA to the mineral-sucrose medium is likely to shorten the time required to grow fairly normal adult plants from spores; but benefit from NAA in the medium after the early stages of protonema and young leaves is questionable. (Tryptone was not used in media for adult plants.) On favorable media most plants have maintained a fairly normal form with a reasonably rapid growth rate. Germination stages were normal, vegetative form is very similar to that of wild plants, and reproductive structures developed by plants of two species appear to be normal. The methods used in establishing and maintaining cultures of *Frullania* are described.

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FRULLANIACEAE OF BURMA. II. FRULLANIA SHANENSIS N. SP.

RUTH D. SVIHLA[1]

Frullania shanensis n. sp.[2] Plants medium in size, light green to dark reddish-brown; leafy stem to 3 cm. long, about 1.3 mm. wide, bipinnate to tripinnate, often compactly branched; branches usually short, averaging about 1.5 cm. long. Stems averaging 154 μ wide. Leaves of main stem conspicuously larger than those of branches, spreading at about a right angle, closely imbricate. Dorsal lobe of main stem leaf broadly ovate, averaging 800 μ long by 690 μ wide; dorsal margin crossing stem to ½ stem width or more beyond; margin entire; apex rounded, slightly decurved; base rounded. Dorsal lobes of branch leaves conspicuously smaller than those of main stem leaves. Ventral leaf lobes of most plants saccate with few explanate ones; those of other plants mostly explanate with only a few saccate ones usually on the branches; all ventral lobes of branches and new growth conspicuously smaller than those of the main stem. Saccate ventral leaf lobes all broadly cap-shaped, 1½ to 2 times as wide as long, about ¼ the stem width or less from the stem; apices rounded to broadly so; mouth very wide, sometimes distally pointed but without a beak or rostrum. Ventral leaf lobes of the main stem averaging 245 μ long by 415 μ wide; those of the branches averaging 154 μ long by 184 μ wide. Leaf subtending a branch usually larger and more rounded than others; ventral lobes usually explanate when present. First leaf of a branch usually with 1 or 2 saccate or 1 or 2 explanate ventral

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[2] Planta mediocris, glauca ad fuscum rufo-brunneum; caules ad 3 cm. longi, 1.3 mm. lati fere 2-3 pinnati multirames. Folia caulina major quam folia ramorum. Lobus dorsalis folii caulini subrotundatus, 800 μ longus, 690 μ latus, apice rotundato, basi rotundata, margine integerrimo. Lobus ventralis folii caulini plerumque saccatus, pileatus, latior quam longior, 245 μ longus, 415 μ latus, ore latissimo, apice late rotundato. Lobus ventralis folii ramorum minor, 154 μ longus, 184 μ latus. Lobi ventrales foliorum in plantis aliis explanati, saccati rarissimi, in aliis, saccati, explanati rarissimi. Stylus subulatus, 3-4 cellis continuis. Amphigastria caulina subrotundata, 415 μ longa et lata, 1/3 ad 1/2 biblobata; amphigastria ramorum minora. Planta monoica. Folia floralia 2/3 ad 3/4 bilobata, lobo dorsali 990 μ longo, 816 μ lato, lobo ventrali angustiore, 990 μ longo, 161 μ lato, apiculato. Amphigastrium florale lyrae simile, 2/3 ad 3/4 bilobatum, cum bracteis basi connatum, lobis acuminatis, sinu rotundato. Perianthium obovatum, 1.4 mm. longum, 950 μ latum, 4-angulatum, margine sinuato, rostro latissimo, 61 μ longo, 154 μ lato, ore papillato.

FIG. 1-20. *Frullania shanensis*. 1. Ventral view of main stem, × 35. 2. Stylus, × 145. 3. Ventral view of branch junction showing (*a*) first leaf

lobes. Stylus about 46 μ long, a row of 3 or 4 cells, sometimes with a base 2 cells wide. Cells of dorsal leaf lobe at margin quadrate, averaging 17μ wide; median cells round, averaging 28.8 μ in diameter with some small trigones and intermediate thickenings; basal cells ovate, averaging 36.7 μ by 32.4 μ, with some small trigones and intermediate thickenings. Underleaves of main stem transversely inserted, flat, subrotund, about as wide as long, averaging 415 μ long and wide, bifid ⅓ to ½ the length; apices acute to somewhat obtuse; sinus acute to rounded; lobes usually divergent toward the tip; margin entire, occasionally with blunt angles at the shoulders, somewhat rounded to the stem at base; underleaves of branches similar but smaller, averaging 184 μ long and wide. First underleaf of a branch bilobed. Plants bisexual. Male inflorescences abundant on short branches often rejuvenating vegetatively, subglobose, usually with 4 to 8 pairs of bracts; bracteoles bifid. Female inflorescences terminal on main stem or branches which are often in clusters. Female bracts bilobed about ¾ their length, sinus acute. Dorsal lobe of female bract broadly ovate, averaging 990 μ long by 816 μ wide; apex broadly obtuse to rounded; margin entire to very slightly sinuate. Ventral lobe of female bract about the same length as the dorsal one but narrower, averaging 990 μ long by 616 μ wide; apex narrowed to an acute point; margin recurved, mostly entire to slightly sinuate. Female bracteole united with both bracts at the very base, lyre-shaped, sometimes with a slender tooth at the base, bifid about ⅔ its length; lobes broadly lanceolate, narrowed to acute apices; sinus obtuse to obtusely rounded. Perianth obovate, averaging 1.4 mm. long by 960 μ wide, 4-angled, sometimes with a low dorsal ridge; keels smooth when young to distinctly sinuate when mature, abruptly narrowed to the beak; beak short and broad, 61 μ long by 154 μ wide with inner cells papillate.

HABITAT: Growing in compact mats with other Hepaticae on bark of trees. TYPE SPECIMEN: Burma, Shan States, Maymyo, Circular Road, 3500

of a branch and (*b*) a subtending leaf, × 35. 4. Dorsal view of main stem, × 35. 5. Ventral view of main stem, × 35. 6. Underleaf, × 35. 7. Ventral leaf lobe, × 35. 8. Ventral view of branch junction, × 35. 9. Cross-section of perianth, × 35. 10. Female bracteole, × 35. 11. Female bracts, × 35. 12. Ventral leaf lobe, × 35. 13. Male inflorescence, × 35. 14. Scheme of branching showing position of male and female inflorescences. 15. Female bracts and bracteole, × 14. 16. Papillate inner cells of perianth beak, × 145. 17. Basal cells of dorsal leaf lobe, × 303. 18. Median cells near apex of dorsal leaf lobe, × 303. 19. Marginal cells near apex of dorsal leaf lobe, × 303. 20. Female inflorescence, × 35. (All drawings from type specimen.)

feet elevation, on bark of trees, *Svihla* 1112, August 9, 1952. Deposited in Herbarium of the University of Washington. SPECIMENS EXAMINED, all collected by the writer in the Shan States, Burma, 1952, unless otherwise stated: MAYMYO. 3500 ft. elev., Government Botanical Garden, 1022a, 1023a, 1025a, 1026a, 1037, 1041b, 1043, 1051, 1052a, June 27, 30. Along road near Baptist Mission Rest House, 1069a, July 10. Along Forest Road, 1090, July 31 and 1158, Aug. 29. Circular Road, 1104a, 1107, 1112 (type), Aug. 9 and 1309b, Nov. 14. East Ridge Road, 1177, Sept. 15. 10 mi. N. of Maymyo on Lashio Road, 1155a, Aug. 16. TAUNGGYI. Along Crag Trails, about 4500 ft. elev., 1179, 1192a, 1194, 1197a, 1212, 1221, 1222, Sept. 19-22 and 1473, 1478a, 1481, Mar. 30, 1953. KALAW. About 3800 ft. elev., 1568, Apr. 10, 1953.

Specimens numbered 1025a, 1043, 1309b from Maymyo about 3,500 feet elevation, and 1568 from Kalaw about 3,800 feet elevation, have mostly explanate ventral leaf lobes with only a few saccate ones on the branches. These plants are also somewhat flaccid and lighter green in appearance but otherwise indistinguishable from the other specimens. Such differences may be due to ecological conditions including light exposure, moisture, altitude or seasonal growth. Since these specimens do not differ from the others in the basic characters of the species, we consider them merely growth forms.

This bisexual species of *Frullania* with a 4-angled perianth and wide-mouthed, cap-shaped ventral leaf lobe seems to be distinct in the subgenus Trachycolea of Spruce. Of those species in this group which are found in southeastern Asia, *F. shanensis* seems closest to *F. saxicolea* which was reported from northwestern Yunnan, China, by Verdoorn (1930). Clark and Svihla (1944) and Frye and Clark (1946) recognized *F. saxicolea* as a synonym of *F. inflata*. So comparing *F. shanensis* with *F. inflata* we find that F. SHANENSIS has dorsal leaf lobes rounded at the bases; cap-shaped, saccate, ventral leaf lobes wider than high; stylus 3-4 cells long; underleaves as wide as long; female bracts with lanceolate ventral lobes narrowed to acute apex; a lyre-shaped female bracteole united with the bracts at the very base. FRULLANIA INFLATA has dorsal leaf lobes with dorsal base appendiculate; saccate ventral leaf lobes galeate, as high or higher than wide; stylus 2-9 cells long; underleaves longer than wide; female bracts with ovate or orbicular ventral lobes not narrowed to the apex; female bracteole ovate, either free or united ⅓ to ½ the length with one or both bracts.

The name *shanensis* (shăn-ĕn′-sĭs) is derived from the Shan States which occupy the high plateau of rolling hills in east-central Burma between the Irrawaddy and Salween Rivers. The species was found only within this area in forests from 3500 to 4500 feet elevation.

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†G. O. K. SAINSBURY, F. L. S.

WILLIAM MARTIN[1]

On July 22, 1957 there passed away at Havelock North in Hawkes Bay, New Zealand, at the ripe age of 77, New Zealand's foremost bryologist in the person of George Osborne King Sainsbury, F. L. S. He was born at Napier on June 1, 1880, being the fourth son of George Edward Sainsbury, barrister and solicitor of that town, and was educated at Wanganui Collegiate School. He thereafter adopted his father's profession and from 1903 to 1911 entered into practice at Gisborne; but for the next six years he took up farming, resuming the rôle of barrister and solicitor in 1917 in partnership with his brother at Wairoa.

In 1908 he married Miss Edith Alice Sherratt. Their only son, who had joined the Royal Air Force, was killed on active service in Africa. Mrs. Sainsbury and two married daughters survive. Apart from three trips to Europe with his parents prior to the Great War of 1914-1918, Mr. Sainsbury lived in New Zealand all his life and for 38 years at Wairoa. He retired in 1946 and thereafter continued to devote his time and energy to the bryology of New Zealand and latterly of Tasmania and Australia. He was an early riser, and every day was planned to a more or less fixed timetable.

Mr. Sainsbury first took up botany as a hobby about 1920 and for two years studied the indigenous flowering plants; but in 1922 he switched over to bryology, then a neglected science in New Zealand, in which field he had latterly an undisputed pre-eminence. His first paper appeared in 1923, being entitled "Notes on *Pittosporum obcordatum*," one of the rarest of New Zealand shrubs of which he had discovered the third known specimen hundreds of miles distant from either of the other two. It is interesting to record that his last find was one of our rarest mosses—*Didymodon*

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calycinus Dixon—of which a single gathering by W. Gray many years before was the sole known occurrence. This moss he found near his home in Havelock North on a roadside bank.

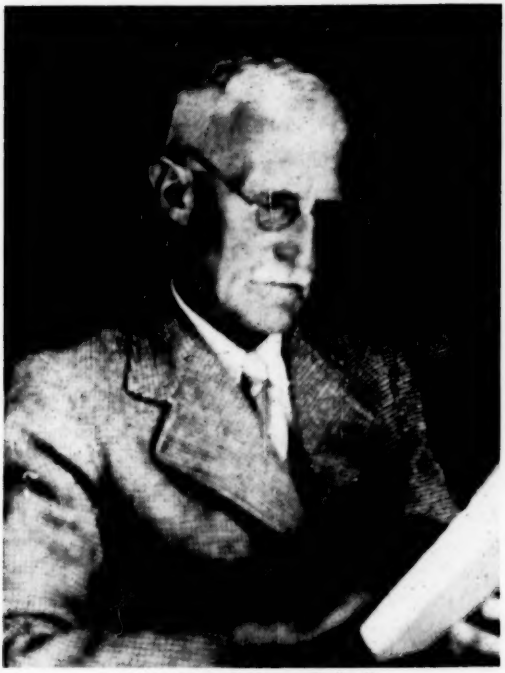
For some 20 years prior to the death in 1944 of Hugh Neville Dixon, the accomplished English bryologist, Sainsbury and Dixon were in continuous communication and collaboration. Dixon in 1929 had completed a series of "Studies in the bryology of New Zealand," based solely on herbarium material, and had introduced order where previously all had been chaos. However, finality was far from having been reached, and as a result of their collaboration in subsequent years some 23 new species and two new varieties were published under their joint authorship. In addition to these Sainsbury himself published 7 new species and 7 new varieties and 18 new combinations.

Sainsbury also consulted other bryology specialists in the persons of Andrews, Bartram, Frye, and Steere. His own work was at all times painstaking and thorough. As a taxonomist he was a "lumper" rather than a "splitter." He collected in several South Island localities, but his main work was mostly confined to the North Island. For many years he was a keen climber, and many of his finds took place on these climbs, especially, he said, when he stopped for lunch. In compiling the list of indigenous mosses he was greatly assisted by collections made by Mrs. E. A. Hodgson, F. L. S., and by K. W. Allison, and in the last 12 years by the writer also.

For close on 30 years paper followed paper, and finally in May 1955 the Royal Society of New Zealand published his *Handbook of the New Zealand Mosses*, destined to be the standard work on the New Zealand moss flora, perhaps for all time. Miss Nancy Adams, the botanical artist who prepared the illustrations, says that "his mood over the book varied from blank despair to extreme optimism in the space of a few hours," but that "he was wonderful to work for, full of fun and jokes."

So numerous were the requests from amateur and professional alike for moss determinations that he described himself as a "naming machine," but the help he so willingly rendered did more to advance bryology in New Zealand than probably Sainsbury ever knew.

Apart from botany he was keenly interested in music and in cricket. He was a real scholar "of the old school," nurtured on the classics in which he retained his interest to the end. He read quite a number of foreign languages. He always regretted never having met Dixon in the flesh, and it is with equal regret that



G. O. K. Sainsbury, F. L. S.
(1880-1957)

neither Allison nor the writer ever met Mr. Sainsbury, though we were perhaps his most regular correspondents.

In later years, he did not enjoy the best of health, and in 1956 he suffered a slight stroke. His final illness was brief, and he died three days after entering hospital. Latterly his botanical research was devoted mainly to overhauling Rodway's Tasmanian herbarium. He collaborated also with J. C. Willis of Melbourne on the mosses of Victoria. His herbarium is housed in the Dominion Museum at Wellington and is probably the only complete collection of New Zealand mosses extant. The following list of his botanical papers may not be quite complete but includes all those known to the writer.

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1948. Bryobartramiaceae, a new moss family. THE BRYOLOGIST 51: 9-13.
1949. New species and varieties of New Zealand mosses. Rev. Bryol. et Lichénol. 18: 111-114.
1950. New species of *Tortula* from subantarctic islands of New Zealand. Sv. Bot. Tidskr. 44: 72-75.
1951. The genus *Hampeella* C. M. in New Zealand. Rev. Bryol. et Lichénol. 20: 94-95.
1951. The taxonomy of the moss *Archephemeropsis trentepohlioides* Renn. Trans. Roy. Soc. N. Z. 79: 203-205.
1952. Critical New Zealand mosses. Rev. Bryol. et Lichénol. 21: 213-225.
1952. Vegetative reproduction in New Zealand mosses. III. THE BRYOLOGIST 55: 71-79.
1953. Notes on Tasmanian mosses from Rodway's herbarium. Proc. Roy. Soc. Tasmania 87: 83-91.

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1955. Handbook of the New Zealand mosses. Bull. Roy. Soc. N. Z. 5: 1-490.

REVIEWS

HENRY A. IMSHAUG. *Catalogue of West Indian Lichens.* Bulletin of the Institute of Jamaica, Science Series, No. 6, *pp.* 1-153. March 20, 1957. Kingston, Jamaica. Price 7/-. —An intelligent approach to tropical American lichens is rendered difficult by the large number of species that have been described or reported from a very broad and diversified area. Both literature and specimens are widely scattered. Dr. Imshaug has carefully listed the 1751 species which have been recorded from the Caribbean islands. The author has meticulously avoided the interjection of personal opinions on the accuracy of reports or the taxonomic value of the 889 species based on West Indian types. Also, he has avoided making nomenclatural changes, although he has in many instances indicated apparent generic relationships without formal transfer. The author plans to continue this work with a manual treatment which will reflect his considerable experience in the field in the West Indies. Meanwhile this catalogue serves its purpose admirably and will no doubt be extremely useful to the lichenologist engaged in floristic or taxonomic studies.—H. A. CRUM.

WINONA H. WELCH: *Mosses of Indiana: an illustrated manual.* 478 *pp.* 253 *fig.* 1 *map.* Indiana Dept. of Conservation, Division of Forestry. The Bookwalter Co., Indianapolis. July 23, 1957. Cloth, $5.00.—This manual, attractively printed and strongly bound, is a worthy addition to the botanical series for which the Indiana Department of Conservation is noted (Deam's books on trees, shrubs, grasses and the entire flora of the state). Dr. Welch is to be congratulated on the completion of a labor of love into which she has put many years of intensive collecting and thorough herbarium studies and her book is highly recommended. She has herself collected in 89 of the 92 counties in Indiana and has seen collections from the remainder. This book provides a fairly technical but straight-forward treatment of the 217 species 34 varieties and nine forms of mosses known from Indiana. It is suitable for beginners with some botanical enlightenment and very useful to more advanced students of bryology, as well, as a means of ready reference. The familial and generic concepts and arrangments are largely those found in Grout's *Moss Flora*, and, in my opinion, are often difficult to justify. For example, it is distressing to find the Hypnaceae as a vast family including nearly all the pleurocarps, and I wonder why *Chamberlainia* is separated from *Brachythecium* when equally good or better segregates such as *Haplocladium* and *Mniobryum* are lumped with *Thuidium* and *Pohlia*, respectively. Such criticisms are no doubt misdirected toward such a book as this and should not, in any case, detract from its very real value as an aid in identification.

Because the flora of Indiana is sufficiently diversified to be typical of much of eastern United States, this book will be almost equally suitable throughout the Middle West, and in most parts of the East much more useful than Grout's *Mosses with a Handlens and Microscope*, which suffers from a basic incompleteness and a fundamental lack of organization. The publication of this new manual is particularly timely inasmuch as Grout's book is now very scarce.

Mosses of Indiana is provided with keys to families, genera and species, complete descriptions as well as diagnostic summaries, illustrations for each species and an illustrated glossary. The illustrations are well chosen from a variety of sources, particularly familiar works by Grout, Jennings and Conard. Some came originally from the *Bryologia Europaea*, although no credit is given to the source. An admirable feature is that the keys have been especially tailored with sterile plants in mind.—H. A. Crum.

Zlatko Pavletic: *Prodromus Flore Briofita Jugoslavije*. 578 *pp.* 1 *table*. Jugoslavenska Akademia Znanosti i Umjetnosti, Zagreb. 1955.—This is a compilation from the literature and presents an annotated catalogue, in Croatian (with a Germany summary), of 916 species of bryophytes, including 715 mosses and 201 liverworts. Local distributions are listed in detail, and brief statements of world distributions are also included. Although further study will no doubt eliminate many records included in this work, the flora is still surprisingly large. Since only some 975 species are known from all central Europe, 715 species from this small area is an impressive number. It would appear, therefore, that this is a rich and probably interesting flora well worth further study.—H. A. Crum.

Three New European Lichen Floras

C. F. E. Erichsen. *Flechtenflora von Nordwestdeutschland*. xxiv + 411 *pp.* 1 *map.* 1 *pl.* Gustav Fischer Verlag. Stuttgart. 1957. Price: DM 48.—. (about $11.46).

J. Hillmann und V. Grummann. *Kryptogamenflora der Mark Brandenburg und angrenzender Gebiete*. Band VIII: Flechten. x + 898 *pp.* 45 *fig.* Gebrüder Borntraeger. Berlin-Nikolassee. 1957. Price: (about $20.00).

[M. P. Tomin]. [*Determination of the Crustose Lichens of the European Part of the U.S.S.R.*] 532 *pp. illus.* [Izdatel'stvo, Akademii Nauk Belorusskoi SSR]. Minsk. 1956. Price: 16 rubles.

Within only a few months three new lichen floras, each certain to receive wide reference, have appeared in Europe. All have descriptions, keys to genera and species, admirable indices, good typography and serviceable bindings.

The German books are posthumous publications. Erichsen's (1867-1945) flora has been prepared for press by W. Christiansen with the assistance of O. Klement and W. Saxen. V. Grummann has enlarged and edited Hillmann's (1881-1943) work to such an extent that he is truly the coauthor.

Northwestern Germany, the region considered by Erichsen, is roughly the size of West Virginia and about half again as large as the Brandenburg

of Hillmann and Grummann. We might expect differences in the lichen floras of the regions, but it is surprising that Erichsen finds about 777 species yet that Hillmann and Grummann find only about 422. Of the 113 genera in the books together, only 68 (60%) are represented in both, 77 (68%) in Hillmann and Grummann, but 104 (92%) in Erichsen. Now as one might guess, such differences only in part reflect real dissimilarities in the lichen flora. Northwestern Germany has a milder climate than the more continental Brandenburg and its lichen flora is consequently of greater diversity. But the authors' taxonomic concepts largely explain the differences.

Since Erichsen's book is less than half as long as Hillmann's and Grummann's but contains almost twice as many species, descriptions are shorter (but still adequate) and bibliographic citations fewer. The Hillmann-Grummann flora abounds in discussions, many preoccupied with nomenclature and morphologic anomalies, aside from the excellent taxomic descriptions. The length of the latter volume might have been reduced (and the high price lowered) if some of the compiled information had been suppressed. For example, after an introductory pooh-poohing of the use of lichen chemistry in taxonomy, the substances reported in the literature are cited in almost every species description even though those reports are not necessarily based on determinations from German specimens. Empirical formulae (even including note of discrepancies in formulae from one chemist to another!) are cited again and again although empirical formulae help the taxonomist not at all.

That the new German books contribute generously to nomenclature can be seen from the catalogue of changes in "Recent literature on lichens" in the last issue of THE BRYOLOGIST. Although in the preparation of a regional flora some modifications in names is expected, it is disappointing to find that of the some 100 in these books all but four are for infraspecific taxa. The wholesale lowering of forms to subforms or elevating them to varieties is a *Namenspiel* unworthy of the talent of these authors. Moreover, when *Cladonia gracilis* finally has 25 varieties and forms it seems that it is time to consider what is really significant in systematics, to see if some measure more accurate than the Latin adjective might be found to evaluate infraspecific variation.

But my criticisms are not meant to depreciate the contribution of these books. Both will aid the European lichenologist in identifying his materials. For the phytogeographer there is a rich source of information drawn from scattered publications and from the wide experience of the eminent authors.

Academician M. P. Tomin's lichen flora is special. It concerns only crustose lichens. The entire text is in Russian and therefore few western lichenologists will use the book casually. Yet for anyone the scientific names are an inventory of the Russian crustose flora. It is a pleasure to find that Tomin's treatment of 767 species includes only five new combinations, three of them re-evaluations of taxa which he had described earlier.—W. L. CULBERSON.

RECENT LITERATURE ON HEPATICS

MARGARET FULFORD[1]

ALLORGE, VALIA & SUZANNE JOVET-AST. *Cololejeunea azorica* V.A. et S.J.-A., Lejeunéacée nouvelle de l'île San Miguel. Mitt. Thüring. Bot. Gesell. 1(2/3): 17-22. 22 *fig.* 1955 [1956]. (Theodor Herzog Festschrift.)

ALLSOPP, A. Controlled differentiation in cultures of two liverworts. Nature 179: 681-682. 1 *fig.* 1957. [*Fossombronia pusilla* and *Reboulia hemisphaerica*]

ARNELL, S. *Lophocolea Herzogii* nov. spec. Mitt. Thüring. Bot. Gesell. 1(2/3): 5-6. 1 *fig.* 1955 [1956]. (Theodor Herzog Festschrift.)

———. A new species of *Cololejeunea* from Moçambique. *Ibid.* 1(2/3): 7-8. 1 *fig.* 1955 [1956]. (Theodor Herzog Festschrift.) [New: *C. moçambiquensis* n. sp.]

———. Hepaticae collected in Cuba and Hispaniola by E. L. Ekman. THE BRYOLOGIST 59(4): 271-276. 6 *fig.* 1956. [New: *Plagiochila ekmanii* n. sp., *P. marginata* n. sp.]

———. A new species of *Cheilolejeunea* from Samoa. Svensk Bot. Tidskr. 50(3): 516-517. 1 *fig.* 1956. [New: *C. upoluensis* n. sp.]

———. Hepaticae collected by K. Byström in Fernando Po and Annobón, West Africa, 1953. Svensk Bot. Tidskr. 50(4): 527-534. 3 *fig.* 1956. (New: *Frullania laceriloba* v. *acutifolia* n. v., *Metzgeria Bystroemii* n. sp., *Phaeoceros* (*Anthoceros*) *Jollyanus* (St.) n. c., *Cyclolejeunea annobonensis* n. sp., *Dicranolejeunea annobonensis* n. sp., *Mastigophora africana* v. *annobonensis* n. v.]

———. Hepaticae collected in South West Africa by Prof. Dr. O. H. Volk. Mitt. Bot. Staats. München 16: 263-267. 3 *Taf.* 1957. [New: *Asterella muscicola* (St.) n. c., *Mannia capensis* (St.) n. c., *Riccia albolimbata* n. sp., *R. albosquamata* n. sp., *R. okahandjana* n. sp., *R.* (Ricciella) *volkii* n. sp.]

———. Notes on South Africa Hepaticae IV. Bot. Notiser 110(1): 17-27. 6 *fig.* 1957. [68 spp.; new: *Aphanolejeunea capensis* (S. Arn.) n. c., *Cephaloziella Schelpei* n. sp., *C. transvaalensis* n. sp., *C. umtaliensis* n. sp., *Marsupella Boeckii* v. *ruwensorensis* n. v., *Scapania Esterhuyseniae* n. sp., *Schistochila limbata* n. sp.]

BUCH, H. Balantiopsidaceae, eine neue Familie der beblätterten Lebermoose. Mitt. Thüring. Bot. Gesell. 1(2/3): 33-24. 1955 [1956]. (Theodor Herzog Festschrift.)

CARR, D. H. Contributions to Australian bryology. 1. The structure, development, and systematic affinities of *Monocarpus sphacrocarpus* gen. et sp. nov. (Marchantiales) Australian Jour. Bot. 4(2): 175-191. 11 *fig.* 3 *pl.* 1956.

CASTELLI, L. Présence d'un oléocorps chez le *Nardia Breidleri*. Rev. Bryol. et Lichén. 26(1/2): 69-70. 3 *fig.* 1957.

[1] Dept. of Biological Sciences, University of Cincinnati, Cincinnati 21, O.

CLARK, LOIS. *Frullania haematocysta.* THE BRYOLOGIST 60(2): 151-154. 25 *fig.* 1957.

———. Hepaticae collected in Nevada by Elva Lawton in 1955. *Ibid.* 60(1): 32-35. 1957. [25 spp.]

CRUM, H. A. Review: Sigfrid Arnell, Illustrated Moss Flora of Fennoscandia. I. Hepaticae. Edited by the Botanical Society of Lund. 308 pp. Fig. 1-98. 1 folding map insert. C. W. K. Gleerup, Lund. THE BRYOLOGIST 60(2): 166. 1957.

———. Review: Henry S. Conard, How to know the mosses and liverworts. Pictured keys for determining many of the North American mosses and liverworts, with suggestions for their study. Revised Edition. x + 226 pp. Fig. 1-442. 3 photographs and 6 cuts (unnumbered). Wm. C. Brown, Dubuque, Iowa. *Ibid.* 60(2): 166-167. 1957.

CRUNDWELL, A. C. Review: Illustrated Moss Flora of Fennoscandia. Edited by the Botanical Society of Lund. I. Hepaticae. By Sigfrid Arnell. 1956. Lund: C. W. K. Gleerup. Price 35 Swedish Crowns. Trans. British Bryol. Soc. 3(2): 305-306. 1957.

DUDA, J. *Scapania Massalongoi* K. M. in den Karpaten. Mitt. Thüring. Bot. Gesell. 1(2/3): 47-50. 3 *Abb.* 1955 [1956]. (Theodor Herzog Festschrift.)

EVANS, ELIZABETH. Review: Bryophytes of the Torneträsk Area, Northern Swedish Lappland. I. Hepaticae. II. Musci. III. General Part. By Olle Mårtensson. K. Svenska. Vetensk. Acad. Avh. Nos. 12, 14, 15. 1955-1956. Trans. British Bryol. Soc. 3(2): 306. 1956.

FITZGERALD, J. W. Review: Flore Générale de Belgique. Bryophytes. Vol. 1, Fasc. 1. By Constant Vanden Berghen. 131 pages, 40 text-figures. Brussels 1955. Trans. British Bryol. Soc. 3(2): 307. 1957.

FULFORD, MARGARET. Sporelings, gemmalings and regeneration in *Blepharostoma trichophyllum* (L.) Dum. Mitt. Thüring. Bot. Gesell. 1(2/3): 245-258. 29 *fig.* 1955 [1956].

———. Sporelings and regenerants of *Ptilidium pulcherrimum* (Web.) Hampe. Rev. Bryol. et Lichén. 25(3/4): 247-253. 22 *fig.* 1956 [1957].

———. The young stages of the leafy Hepaticae: A résumé. Phytomorphology 6(3/4): 199-235. 236 *fig.* 1 *tab.* 1956 [1957].

——— & VIOLET DILLER. Studies on the growth of *Haplomitrium.* I. Organic media. Rev. Bryol. et Lichén. 25(3/4): 239-246. 27 *fig.* 1956 [1957].

GILLET, H. & SUZANNE JOVET-AST. Deux *Riccia* de l'Aïr (Territoire du Niger). Rev. Bryol. et Lichén. 26(1/2): 62-66. 3 *fig.* 1957. [New: *R. saharensis* n. sp.]

GROLLE, R. Revision der *Clasmatocolea*-Arten. Rev. Bryol. et Lichén. 25(3/4): 288-303. 3 *Taf.* 1956 [1957] [New: *Choneolea* n. g., *C. doellingeri* Nees) n. c., *Phragmatocolea* n. g., *P. innovata* (Herz.) n. c.]

———. Ein dringender Fall für die Liste der *nomina conservanda.* Rev. Bryol. et Lichén. 26(1/2): 82-84. 1957.

HARA, M. Revision of the family Jungermanniaceae in Shikoku, southern Japan (1). Research Rept. Kôchi Univ. 5(33): 1-9. 2 *fig.* 1956. Kôchi, Japan.

———. Notes on the hepatic flora of the Amami Islands, the southernmost region of Japan. Rept. USA Marine Biol. Sta. 4(3): 1-23. 1 *tab.* 2 *pl.* 1957. [Publ. by Biol. Lab. Fac. Lit. & Sci. Kochi Univ., Kochi, Japan.]

HATTORI, S. Editor. Hepaticae Japonicae Exsiccatae. Ser. 8(nos. 351-400) 1956. Jour. Hattori Bot. Lab. 17: 75. 1956. [New: *Cololejeunea* (*Leptocolea*) *longilobula* (Horik.) n. c., *C.* (subg. *Taeniolejeunea*) *verdoornii* (Hatt.) n. c., *Solenostoma cyclops* (Hatt.) n. c., *S. decurrens* (St.) n. c.]

HERZOG, T. Über einige Arten der Lebermoosgattungen *Odontolejeunea* und *Cyclolejeunea*. Rev. Bryol. et Lichén. 26(1/2): 51-59. 5 *fig.* 1957.

———. Eine neue *Acrobolbus*-Arten aus Westaustralien. Rev. Bryol. et Lichén. 26(1/2): 60-61. 1 *fig.* 1957. [New: *A. cyaneus* n. sp.]

———. [See also K. Müller, *in* Rabenhorst's . . . 1956]

HODGSON, AMY. New Zealand Hepaticae (Liverworts)—IX. A review of the New Zealand species of the genus *Lepidozia*. Trans. Roy. Soc. New Zealand 83(4): 589-620. 2 *fig.* 1956. [New: *L. martini* n. sp., *L. remotifolia* n. sp., *L. meridiana* n. sp., *L. meridiana* v. *paludicola* n. v.; *L. Herzogii* n. nom.; 33 species included]

HOFLER, K. VON. Über einige Lebermoose des Bayreuthen Raumes und ihre plasmatischen Trockengrenzen. Naturw. Gesell. Bayreuth Ber. 1953/1954: 67-87. 1954.

INOUE, H. A new and additional descriptions of Hepaticae from Titibu District. Jour. Jap. Bot. 31(11): 340-344. 2 *fig.* 1956. [3 spp.; new: *Lophocolea itoana* n. sp.]

———. Studies on spore germination of Hepaticae. I. *Trichocoleopsis sacculata* (Mitt.) Okam. Jour. Hattori Bot. Lab. 17: 55-58. 9 *fig.* 1956.

JONES, E. W. *Lophozia opacifolia* Culmann in Scotland. Trans. British Bryol. Soc. 3(2): 180. 1957.

———. African Hepaticae XII. Some new or little-known Lejeuneaceae. *Ibid.* 3(2): 191-207. 6 *fig.* 1957. [New: *Caudalejeunea yangambiensis* Vanden Berghen) n. c., *Lopholejeunea kilimanjarica* n. sp., *L. laciniata* n. sp., *L. revoluta* n. sp., *Mastigolejeunea rhodesica* (Vanden Berghen) n. c., *Leptocolea punctata* n. sp., *L. distalopapillata* n. sp.]

———. African Hepatics. XIII. The Ricciaceae in tropical Africa. *Ibid.* 3(2): 208-227. 7 *fig.* 1957. [18 taxa, keys; new: *Riccia intermedia* n. sp., *R. nigrosquamata* n. sp., *R. berrici* n. sp.]

———. Review: Die Lebermoose Europas. By Karl Müller. 3rd edit. Bd. 6, of Rabenhorst's Kryptogamenflora von Deutschland, Österreich und der Schweiz, parts 6-8. Price Deutsch-Marks 22.60 each. *Ibid.* 3(2): 307-308. 1957.

JOVET-AST, SUZANNE. Deux *Colura* nouveaux de Madagascar. Rev. Bryol. et Lichén. 25(3/4): 272-276. 2 *fig.* 1956 [1957]. [New: *C. bicornis* n. sp., *C. inornata* n. sp.]

———. *Diplasiolejeunea galloana*, espèce nouvelle d'Amérique tropicale. *Ibid.* 25(3/4): 277-279. 21 *fig.* 1956 [1957].

———. *Riccia frostii* Aust. au Sahara et en Turquie. *Ibid.* 26(1/2): 67-68. 1957.

KAHN, S. A. Observations on species of *Leptocolea*. THE BRYOLOGIST 60(1): 23-28. *22 fig.* 1957. [New: *L. mirpurensis* n. sp.]

———. Studies in Ricciaceae of East Pakistan. I. New and little known species of *Riccia*. *Ibid.* 60(1): 28-32. *5 fig.* 1957. [New: *R. arnellii* n. sp., *R. bengalensis* n. sp.]

KODAMA, T. *Cololejeunea haskarliana* and its allied species in Japan. Jour. Hattori Bot. Lab. 17: 64-74. *4 fig.* 1956. [New: *C. haskarliana* v. *haskarliana* n. v., v. *spinosa* (Horik.) n. c., v. *nakajimae* (Hatt.) n. c.]

KUCYNIAK, J. Le *Lophozia incisa* dans le Québec. Ann. de l'ACFAS 18: 74-77. *1 fig.* 1952.

MÜLLER, K. Die Lebermoose Europas (Musci hepatici). *In* Rabenhorst's Kryptogamen-flora. VI. Aufl. 3. Lief. 6-8, edit. T. Herzog. Lief. 6: *pp.* 757-916. *Fig.* 248-326; Lief. 6: *pp.* 917-1076. *Fig.* 327-402; Lief. 8: *pp.* 1077-1220. *Fig.* 403-472. 1956. [New: *Marsupella andreaeoides* (Ldbg.) K. M. n. c., *Cephaloziella rubella* v. *Sullivantii* (Aust.) K. M. n. c., *C. Massalongoi* v. *compacta* (Jörg.) K. M. n. c., *C. Starkei* v. *nigrimonasteriensis* (Douin) & v. *carnutensis* (Douin) K. M. n. v., *Telaranea silvatica* (Ev.) K. M. n. c., *T. trichoclados* (K. M.) K. M. n. c., *T. setacea* (Web.) K. M. n. c.]

MEIJER, W. Notes on some Malaysian species of *Anthoceros* L. (Hepaticae)-I. Reinwardtia [Indonesia] 2(3): 411-423. *8 fig.* 1954. [*A. tjibodensis* n. nom.]

PANDÉ, S. K. & R. UDAR. Studies in Indian Metzgerineae. -III. *Calycularia crispula* Mitten. Phytomorphology 6(3/4): 331-346. *89 fig.* 1956 [1957].

SCHUSTER, R. M. Notes on nearctic Hepaticae. XII. *Marsupella paroica* n. sp. THE BRYOLOGIST 60(2): 145-151. 1957.

SCHARWZ, O. Theodor Herzog. Mitt. Thüring. Bot. Gesell. 1(2/3): 3. 1 *portr.* 1955 [1956]. (Theodor Herzog Festschrift.)

SMEJKAL, M. *Fossombronia dumortieri* (Hübener et Genth) Lindberg—nova moravská jatrovka. Československ. Bot. Listy 4(1): 13. 1951.

STANGE, LUISE. Ueber Regeneration bei *Riella affinis*. VIII Congr. Intern. Bot. Compt. Rend. d. Séan. et. Rapp. et Comm. Sect. 16: 63-68. 1957.

SZWEYKOWSKI, J. *Lophozia ascendens* (Warnstorf) Schuster (=*Lophozia gracillima* Buch), a new hepatic for the Polish flora. Fragmenta Floristica et Geobotanica, Ann. 1(1): 173-181. *6 fig.* 1954.

TAVARES, C. N. & I. M. TAVARES. Hepaticological notes—IV. The genus *Blasia* (Mich.) L. in Portugal. Rev. Fac. Cién. Lisboa II. C. 5(2): 225-228. 1957.

TAYLOR, JANE. A new Australian hepatic. (*Riella spiculata*) Kew Bull. 1954(1): 45-47. *illus.* 1954.

UDAR, R. On two species of *Riccia* new to Indian Flora. Current Science [India] 25: 232-233. *10 fig.* 1956.

———. On the synonomy of some Indian species of *Riccia*. Current Science [India] 26: 20-22. *11 fig.* 1957.

———. Culture studies in the genus *Riccia* (Mich.) L. Jour. Indian Bot. Soc. 36(1): 46-50. *16 fig.* 1957.

WHITEHOUSE, EULA. Additions to the hepatic flora of Texas. Mitt. Thüring. Bot. Gesell. 1(2/3): 231-235. 1955 [1956].

WITTLAKE, E. B. *Riccia canaliculata* Hoff. in Arkansas. Amer. Midland Nat. 54: 250-252. 1955.

RECENT LITERATURE ON LICHENS—24[1]

WILLIAM L. CULBERSON[2]

ABBAYES, H. DES. Lichens de la région malgache. I. Espèces foliacées et fruticuleuses récoltées à Madagascar, principalement par H. Humbert, et à Mohéli (Comores), par l'Institut de Recherches scientifiques de Madagascar. Mém. de l'Inst. Sci. de Madagascar, sér. B. 7: 1-25. 5 *fig.* 1956. [36 spp. New: *Anzia madagascarensis* n. sp., *Ramalina praetermissa* n. sp. and v. *amplior* n. v.]

———. Quelques *Cladonia* (Lichens) des régions inter-tropicales, nouveaux ou peu connus, conservés dans l'Herbier de Kew. Kew Bull. 1956(2): 259-266. 1956. [15 taxa. New: *C. vulcanica* f. *melanodes* (Nyl.) n. c., f. *isidioclada* (Mont. & v. d. B.) n. c.; *C. siamea* n. sp., f. *evoluta* n. f., f. *pulvinata* n. f.; *C. salzmanni* f. *ascypha* n. f.; *C. erythrospera* v. *thomsonii* f. *nuda* n. f.]

ARKLEY, V., F. M. DEAN, A. ROBERTSON & P. SIDISUNTHORN. Usnic acid. Part XII. Pummerer's ketone. Jour. Chem. Soc. [London] 1956: 2322-2328. 1956.

ASAHINA, Y. Lichenologische Notizen (§ 126-127). Jour. Jap. Bot. 32(5): 129-133. 5 *fig.* 1957. [On *Parmelia* cf. *rutidota* Tayl., *P. pseudorutidota* Asahina and *Dermatocarpon moulinsii* (Mont.) Zahl.]

———. Lichenologische Notizen (§ 128-129). *Ibid.* 32(6): 161-164. 3 *fig.* 1957. [On *Lobaria linita* v. *tenuior* (Hue) Asahina, *L. sachalinensis* Asahina and *L. s.* v. *kazawaënsis* Asahina.]

AWASTHI, D. D. Studies on the lichens of India. Proc. Indian Sci. Congr. 40(3): 72-73. 1953 [Abstract.]

———. Two new species of *Cetraria* from eastern Nepal. *Ibid.* 41(3): 116. 1954. [Abstract.]

———. A preliminary note on "Contributions to the lichen flora of eastern Nepal." *Ibid.* 41(3): 117. [Abstract.]

———. On new lichens from the Himalayas—I. Proc. Indian Acad. Sci. 45: 129-139. *Pl.* 10-11. 1957. [New: *Cetraria pallida* n. sp., *C. nepalensis* n. sp., *Physcia askotensis* n. sp., *P. melanotricha* n. sp., *P. endococcina* v. *latiloba* H. Magn. n. v., *Anaptychia himalayensis* n. sp., *A. pellucida* n. sp., *Peccania höegii* n. sp.]

———. A new species of *Parmelia* from Kodaikanal, south India. Current Sci. 26: 123-124. 1 *fig.* 1957. [New: *P.* (Hypogymnia) *pseudobitteriana* n. sp.]

[1] Names of new taxa from the Americas are marked with an asterisk (*).

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NEWS AND NOTES

Bryologists are reminded that they can greatly help in the preparation of the *Index Muscorum* by sending reprints of their papers with new taxa or notes on synonymy or nomenclature to Prof. R. van der Wijk.

H. L. Blomquist has received a grant from the National Science Foundation for a revisional study of North American peatmosses to be published in book form with illustrations. Special attention will be given to specific and infraspecific variability, phylogeny, nomenclature, ecology and distribution. He will spend the spring semester of 1958 in Puerto Rico completing studies on marine algae begun in a previous visit in 1941 and 1942.

Nieva Veloira (University of Tennessee) would like to buy a copy of Grout's *Mosses with Hand-lens and Microscope*.

John W. Thomson has received an NSF grant for the preparation of a manual of arctic American lichens.

Mimeographed copies of a list of mosses supplementing the annotated list of species of Californian mosses which appeared in 1950 are available from L. F. Koch (207 Harker Hall, University of Illinois, Urbana). The list includes a bibliography and summary of additions, and corrections to the known moss flora of California since 1950.

At the Stanford meetings: New officers of the American Bryological Society, elected for a 2-year term beginning Jan. 1, are John W. Thomson, Pres.; Ronald L. McGregor, Vice-Pres.; Virginia S. Bryan, Sec.-Treas.

A further discussion of the starting date for moss nomenclature at the Stanford meetings showed the order of preference to be Jan. 1, 1801, April 1801, Dec. 31, 1801. It was noted that the ABS herbaria were omitted from the *Index Herbariorum*. Official abbreviations were suggested as follows: ABSH (hepatics), ABSL (lichens), ABSM (mosses).

The Executive Committee approved the suggestion that a complete selection of specimens available in the accumulated collection of the Hepatic Exchange be awarded to the author of the paper on hepaticology which is judged to be outstanding during recent years. The award is open only to students and amateurs, not to professional bryologists. The number of specimens will likely amount to around 180 to 200. Further details will be worked

out by the members of the Hepatic Exchange.

Twenty-seven people attended the foray which was divided into two groups for the convenience of lichenologists and bryologists. A report will be published later by John Thomson and Edwin Ketchledge.

Future meetings of the American Bryological Society (in conjunction with the A.I.B.S.) have been pegged at the University of Indiana (1958), Pennsylvania State University (1959), Oklahoma A. & M. College (1960) and Massachusetts State University (1963).

FRANS VERDOORN has been appointed Director of the new Biohistorical Institute of the University of Utrecht. This institute will be associated with the Botanical Museum and Herbarium of that university and will be concerned with humanistic aspects of the life sciences, with some special reference to botany. The activities of Chronica Botanica have, with the exception of certain biohistorical publications, been taken over by the Ronald Press of New York, although Dr. Verdoorn will act as Consulting Editor.

A. J. SHARP has been elected Treasurer of the Botanical Society of America for 1958.

GRACE BLANCHARD IVERSON, who has spent the last year in Belgium, will return to California early in January and will divide her time between Berkeley (where her husband will hold a fellowship) and Stanford.

MR. RABINDAR NATH SINGH of Ludhiana, Punjab, is taking graduate work with A. J. Sharp at the University of Tennessee. He plans to study the bryogeography of the Punjab and hopes to locate all Punjab collections in North American herbaria, or collections from near the Punjab.

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